Regd. No. M. 2799

Current Science

Vol. 28, No. 6 JUNE 1959 Pages 227-266

Current Science

Vol. XXVIII] JUNE 1959 [No. 6

CONTENTS

Letters to the Editor

THE STATISTICAL CHARACTER OF ATOMIC PROCESSES

L. ROSENFELD

Nordisk Institut for Teoretisk Atomfysik, Copenhagen

THERE still lingers a popular view of science (which scientists did much to encourage and nothing to dispel), according to which a scientific theory is accepted when it is in accord with *all* the facts it purports to describe: hence the unrockable certainty of scientific statements in contrast to the frailty of human judgments of other origin. Apart from the obvious tautology implied by the consideration of the totality of the evidence, this naive picture of the way in which science is made is as remote from reality as the meticulous preciseness of preraphælite painting. Physicists know very well, when they are at work (although they do not usually put it down in so many words when they write about their work), that their decisions to adopt or reject theories are always based on a *very small* number of facts, which they regard as crucial.

This behaviour of the physicist is not as reckless as it seems; not more so, in fact, than that of the engineer wanting to assess the strength of a steel girder: he will not probe every inch of it, but only perform a small number of adequately distributed *sample* measurements. Likewise, the scientist proceeds by *sample tests* of his theories and relies upon this sampling in assessing their adequacy; whether the sampling is judicious, or how extended is its scope, can only be ascertained by trial and error. Thus, in science as in every other walk of life, all decisions, all actions are taken on the strength of truth-judgments which are of a fundamentally statistical character. There is here no sharp distinction between 'practical' and 'philosophical' truth: attempts to draw such a distinction have only led to 'Scheinprobleme', as for instance the very problem of the 'foundation' of statistical causality.

Mathematicians know that the concepts and axioms of the theory of probabilities form a self-contained logical system which does not need any extraneous foundation. Professional statisticians use this theory as a tool perfectly adapted to their needs, and never had any qualms about its 'ultimate' justification. Only the physicists, by their uncritical acceptance of a deterministic philosophy, were long prevented from recognising in statistical causality the actual form of all scientific reasoning. When, however, in order to formulate in rational terms (i.e., without running into *trivial* contradictions) the fundamental laws of atomic processes, dominated by the existence of the quantum of action, it was found necessary to introduce *complementarity* as a new kind of logical relationship between physical concepts, it became clear that the causal links between atomic phenomena are no longer necessarily determinate, like in classical physics, but do indeed belong to the more general, statistical types.

The stumbling block to the understanding of complementarity and the appreciation of its significance is undoubtedly the belief in the absolute validity of the deterministic form of causality: for those who entertain this belief, statistics must appear as an incomplete mode of description, which has to be based upon some deterministic substratum. Thus, by postulating the necessity of such a substratum in the atomic case, they create for themselves the problem of finding it,—without realising, apparently, the deceptive character of such an argument.

The traditional conception of determinism is not so simple as it looks. The idea is that, if you know all the *relevant* circumstances at some instant, you are able to predict in a unique way what is going to happen next. The restriction implied by the word 'relevant' is obviously essential in order to avoid a tautology: but the very necessity of thus selecting from the infinite wealth of events only a limited number of data on which inferences about the future (or the past) are to be based emphasises the highly abstract character of deterministic causality. That such inferences should at all be possible, that it should be possible to set up differential equations involving only a few variables and allowing valid predictions or retrodictions about the states describable in terms of these variables, is indeed very remarkable; but it is a situation of fact, a 'law of nature', and as such it partakes of the limitations inevitably affecting all the concepts and statements by which we try to express in finite terms the salient features of an infinite reality. No doubt, the domain of validity of determinism as the form of causality characteristic of the laws of matter, in bulk—the laws of motion of material bodies as well as those of electro-magnetic radiation and gravitation—is so vast that it was natural to regard this type of causality as the universal one, so long as there was no suggestion in experience of situations to which it would not apply: but it is fatal to lose sight of the

provisional character of conceptual extrapolations of this kind and to proclaim them 'necessary' features of reality.

In dealing with quantal processes, we are indeed faced with such a sharp dilemma that it is impossible to dodge it. The very definition of the quantum of action exhibits a seemingly paradoxical character, since the two quantities—energy-momentum and period-wavelength—whose product is equal to Planck's constant refer to mutually exclusive aspects of the atomic object, respectively idealised as a punctiform particle and an indefinitely extended plane wave. It is therefore clear that the existence of the quantum of action imposes a limitation to any analysis of an atomic process in terms of such classical idealisations, and thereby introduces a statistical element into the description. It is impossible, for instance, to assign the electron in a stationary state of the hydrogen atom a continuous motion along a trajectory in the classical sense, because such a motion would imply a continuous variation of action, in violation of the quantum law. The quantal transitions thus appear as phenomena only definable as a whole, in terms of the initial *and the final* state; and in view of the multiplicity of possible final states, their occurrence can only be characterised by relative probabilities. It is also clear that no introduction of 'new concepts' can have any influence on this situation, since such concepts (in order to be intelligible) must be somehow related to the classical concepts adapted to the account of our direct experience, and this relation must be compatible with the law of the quantum of action: thus, all typically quantal concepts, like spin or parity, are defined in classical terms, but their definition necessarily contains a statistical element.

It is of decisive importance for the consistency of quantum theory that the limitations imposed by the existence of the quantum upon the use of classical ideas should not be absolute, but only relative, and, in fact, reciprocal. Every classical concept corresponds to a situation which can be reproduced, in principle, with any accuracy by an appropriate experimental arrangement: but every such arrangement precludes (up to a reciprocal latitude) the possibility of defining the concept which characterises the complementary situation. This ensures that the statistical causality inherent in the description of quantal processes does not imply any incompleteness of this description. Complementarity provides a logical framework wide enough to comprehend in a rational way those aspects of the atomic processes which, while mutually exclusive, are equally necessary parts of an exhaustive account.

In this connection, it must be stressed that the requirement of completeness cannot be formulated absolutely, but depends on the type of causality of the mode of description envisaged: it is different for a deterministic and for a statistical theory, and it is unreasonable to demand from the latter that it should conform to criteria applicable to the former. Failure to realise this has led to a curious misapprehension of the consequences of the reciprocal limitations of measuring processes for the completeness of the quantal description of the phenomena. When we have ascertained by observation some characteristic of a system, we have irrevocably deprived ourselves of the possibility of ever knowing anything about the complementary feature of this system: how then, it is asked, dare we assert that our description of the system can ever be complete? Here again, it is apparently overlooked that whatever observations are made upon atomic systems are in the nature of a *sampling*, a very minute sampling indeed of the innumerable *identical* systems which make up the universe. The identity of constitution of all atomic systems of the same species, implied in the formulation of such a fundamental law of nature as the exclusion principle, is quite essential for the atomistic picture of the universe to make any sense at all. Only this identity gives a meaning to probability statements about the behaviour of a system of definite species. The complementarity of different types of behaviour implies that we cannot observe these types of behaviour on the same sample; but we have many samples at our disposal, and the fate of a particular sample is of no interest: we are only concerned with predictions valid for *any* sample.

No less essential than completeness is the requirement of objectivity which every scientific theory must fulfil. Again, it is easily seen that the widening of our conception of causality implied in complementarity does not in the least conflict with this requirement as commonly understood. The argument which led to the recognition of the new form of complementary relation between quantal phenomena is a quite rigorous one: at no stage has any arbitrary postulate been introduced about what 'reality' ought or ought not to be like. It is true that in our account of atomic phenomena explicit reference must be made to the interaction of the

atomic objects with the systems of macroscopic bodies constituting the apparatus by means of which these objects are observed. But this circumstance, far from bringing in any subjective element, enables us to put the fundamental laws of quantum theory in a form valid for any observer, and accordingly objective in exactly the same sense as the laws of classical physics. It is clear that, strictly speaking, all physical concepts imply some reference to conditions of observation. In classical physics, we may usually forget about it and indulge in the illusion that we are contemplating the unrolling of the phenomena as a spectacle in which we have no part; when dealing with atoms, we must adapt our epistemology more closely to the real situation we occupy in the universe.

There is an undeniable similarity between the epistemological conclusions, drawn from the peculiar character of the quantal laws, about the active part of the observer in defining the phenomena, and the insistence of the early positivists on the essential part played by our sensations in determining our knowledge of the external world. This only means that, to that extent, the early positivist movement was a healthy reaction against the shallow metaphysics of mechanistic materialism. But why should scientists be made responsible for the later positivists' blundering into a metaphysics of their own? No scientist would accept the extreme positivist contention that there is nothing more in statements about phenomena than the conceptual expression of relations between sensations: he would maintain that such statements refer primarily to real processes of the external world; our mental representation of these processes being itself, of course, subject to definite laws depending upon our sensorium.

Clearly, the point of view of complementarity finds its natural place in the line of development of a philosophy rooted in a straightforward common sense approach to the realities of existence,—a philosophy which historically found its most vigorous expression in Josef Dietzgen's early writings. This is the true line of development of the philosophy of science, because on the one hand scientific thought can only thrive if it is in harmony with the social function of scientific activity, and on the other hand all philosophical abstractions can only find in science a sure foundation.

TRAPPED RADIATION AROUND THE EARTH

INVESTIGATIONS with the help of satellites and space probes have resulted in the discovery of a new phenomenon which is of great scientific interest in space research. Whereas in many cases the findings from the cosmic ray counters and radiation detectors carried by early satellites were in full agreement with theory and had been predicted for some years, there were also surprising facts.

Sputnik II, launched on November 3, 1957, carried a single shielded Geiger counter to measure cosmic ray counting rate. The data received showed that the counting rate increased almost linearly from 30° N. to 60° N. geomagnetic latitude at a constant altitude. As a function of the altitude the rate increased gradually from 225 to 700 km. During the flight, however, an unusual "event" occurred when the counting rate increased by 50%, and there was no correlation with any event noticed on the ground. Later experience gathered from Sputnik III, launched on May 15, 1958, revealed that there is an electron flux north of 60° N. at relatively low altitudes, and it became evident that the "event" observed with Sputnik II was a part of this phenomenon.

Again, the first U.S. IGY satellite, Explorer I, launched on February 1, 1958, had as its primary purpose the study of cosmic radiation in the vicinity of the earth. The observations with this satellite, as well as those with Explorer III, launched on March 26, 1958, led to the discovery of the existence in the region around the earth of a belt of high intensity corpuscular radiation due to natural geophysical causes.

The first report of this discovery and its interpretation in terms of magnetic trapping was given by James A. Van Allen, on May 1, 1958, at an IGY Symposium of the National Academy of Sciences and the American Physical Society. To secure more detailed knowledge of the structure and extent of these radiation belts, now known as the Van Allen Belts, it was felt necessary to collect data of observations carried to very great radial distances, several times the earth's radius. The joint venture, under US–IGY operations, of the State University of Iowa, the Jet Propulsion Laboratory of the California Institute of Technology and the U.S. Army Ballistic Missile Agency, has yielded extremely significant

results gathered from the deep space probe, Pioneer III.

A preliminary outline of these results is given by Prof. James A. Van Allen and Louis A. Frank in *Nature*, February 14, 1959, from which the relevant data given in this note have been taken.

Log of flight (Pioneer III) launched from Cape Canaveral, Florida, at 0545 U.T., December 6, 1958. 28·5° N. 80·8° W.) Burn-out velocity (space fixed) 10·68 km./sec. Apogee :

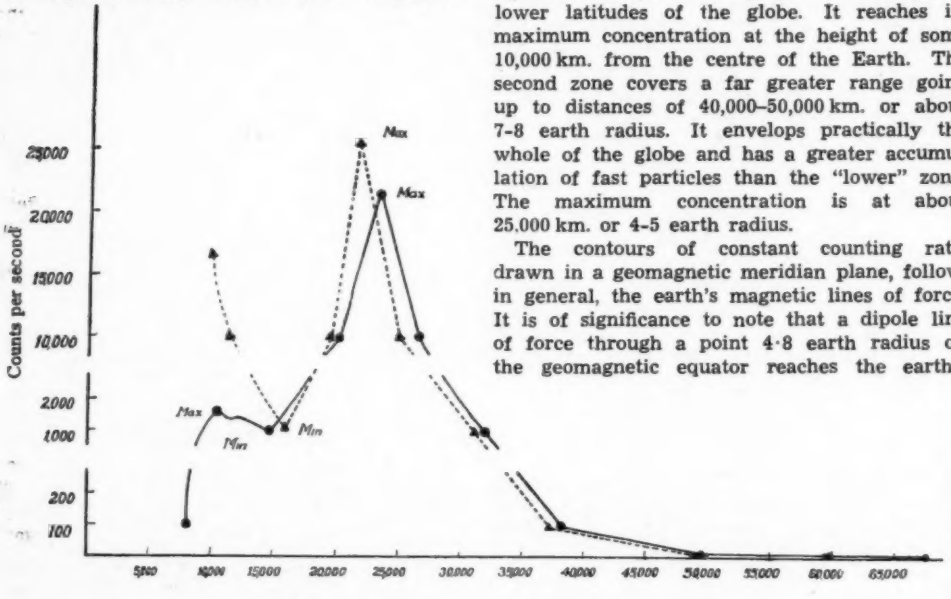


FIG. 1. Plot of counting rate *versus* radial distance from centre of Earth, in the Pioneer III observation. Continuous curve shows the out-bound leg of the flight, December 6, 1958, 0549-1410 U.T. Dotted curve shows the in-bound leg of the flight, December 7, 1958, 1520-1930 U.T. Note: Three different scales are used in the ordinate, indicated by breaks in the curves.

108,700 km. radial distance from centre of Earth, 23·74° S., 145·5° E. at 0049 U.T., December 7. Extrapolated impact with the Earth : 16·18° N., 20·30° E., at 1943 U.T., December 7.

During its flight of 38 hrs., Pioneer III was tracked by the JPL tracking stations for 25 hrs., the maximum time it was above the horizon for these stations.

Due to excellent telemetry, continuous radiation observations were obtained on the out-bound leg of the trajectory to a radial distance from the centre of the Earth of 107,400 km. (nearly to apogee) and from 60,000 km. to 9,400 km. on the in-bound leg.

The curve Fig. 1, shows the plot of the counting rate against distance from the centre of the earth, along the trajectory. It will be seen that there are two distinct, widely separated zones of high intensity. Detailed analysis of the data from Pioneer III, together with those obtained from the Sputniks and other satellites, shows that in a geomagnetic meridian plane, the first zone is a dough-nut-shaped region centred on the geomagnetic equator and located chiefly above the relatively lower latitudes of the globe. It reaches its maximum concentration at the height of some 10,000 km. from the centre of the Earth. The second zone covers a far greater range going up to distances of 40,000–50,000 km. or about 7-8 earth radius. It envelops practically the whole of the globe and has a greater accumulation of fast particles than the "lower" zone. The maximum concentration is at about 25,000 km. or 4-5 earth radius.

The contours of constant counting rate, drawn in a geomagnetic meridian plane, follow, in general, the earth's magnetic lines of force. It is of significance to note that a dipole line of force through a point 4·8 earth radius on the geomagnetic equator reaches the earth's surface at a geomagnetic latitude of 63°, and one through a point 10 earth radius, at a geomagnetic latitude of 71·5°. These latitudes are approximately the lower and upper boundaries of the usual zone of maximum auroral activity.

The origin of these trapped radiation belts is still a matter of conjecture. Various explanations have been given but it is generally believed that the inner and outer zones may have different physical origins, for example, the outer one due to solar plasma and inner one due to cosmic ray albedo decay products.

THE PRESENT STATUS OF HYPERCONJUGATION

C. N. R. RAO

Department of Chemistry and Lawrence Radiation Laboratory, University of California, Berkeley, California, U.S.A.

THE heat of hydrogenation of an olefin is appreciably decreased by the presence of alkyl substituents on the unsaturated carbon atom. This effect was explained by Mulliken, Reike and Brown[1] on the basis of a new type of conjugation[2]—"hyperconjugation". The resonance which results from the hyperconjugation of the alkyl group with the double bond was supposed to stabilize the molecule in the usual way and thus reduce its heat of hydrogenation. Hyperconjugation in acetonitrile or propylene, for example, would then be explained in terms of resonance between the classical structure and the *no-bonded* structure :

$$H_3C-C\equiv N \qquad H_2C=C=\overset{H^+}{\overline{N}}$$

$$H_3C-CH=CH_2 \qquad H_2C=CH-\overset{H^+}{\overline{C}}H_2$$

Although this type of first order hyperconjugation was never considered to be as important as resonance in benzene, it was expected to slightly weaken the C–H bonds and strengthen the C–C (single) bonds. A second order hyperconjugation was also considered to result from the interaction of an alkyl group with another alkyl group instead of with a multiple bond. Both molecular orbital and valence bond methods have been used to explain hyperconjugation.

A necessary consequence of hyperconjugation would be the change in the lengths of the C–H bond in the alkyl group and the C–C bond adjacent to a double or triple bond. In toluene, the increase in the C–H bond (of the methyl group) was calculated to be only 0·001 A ;[1] but the decrease in the C–Me distance has been found to be appreciable. The C–Me distance in toluene is 1·51 A[3] and in methyl acetylene[4] and acetonitrile[5,6] it is 1·46 A, compared to the normal C–C distance of 1·54 A in ethane. It was however recognized that part of these bond shortenings was due to the change in the atomic radius from tetrahedral to trigonal or digonal carbon and about one-half of the observed shortening was due to hyperconjugation.[7]

Hyperconjugation was also considered to be responsible for the dipole moment of alkyl benzenes. Toluene has a dipole moment of 0·4 D and the methyl group is positive with respect to the benzene ring. It was therefore assumed that the electrons released by the alkyl group were delocalized which would result in a resonance stabilization of the molecule. This idea was supported by the heat of combustion of toluene which indicated toluene to be about 1·5 kcal./mole more stable than predicted by the additivity relations. Such stabilizing effects were founded in a number of hydrocarbons.[1,8]

The ionization potentials of methylated ethylenes[7,9,10] and the absorption spectra[2,10–12] were also given as evidence for hyperconjugation. Alkyl substitution in unsaturated systems in general causes displacements towards longer wavelengths. However, part of these effects were considered to be due to inductive interaction.[7]

The view that C–H hyperconjugation is the prominent mode of electron release by alkyl substituents when attached to an electron demanding system was originally proposed by Baker and Nathan[13] as an explanation of certain rate and equilibrium data. The Baker-Nathan effect was in the order Me > Et > i–Pr > t–Bu, exactly reverse of what one would expect if the electron release were by inductive mechanism.

The idea of hyperconjugation has received great attention from physical and organic chemists alike and through the years a great deal of physical and chemical evidence has been accumulated in support of this idea.[10,14,15] However, recently there have been a number of observations which cannot be explained in a simple fashion by hyperconjugation and the situation has become controversial. In this article the author has attempted to discuss briefly the present status of hyperconjugation in the light of the more recent investigations.

Recent molecular structure investigations in several laboratories on derivatives of acetonitrile and methyl acetylene (Table I) have conclusively established that the length of a carbon-carbon single bond adjacent to a triple bond (*i.e.*, a bond between sp and sp^3 carbon atoms, designated as C–C′ in Table I) is always close to 1·46 A. It is interesting to note that the C–C′ distance is not dependent on the substituents on the sp^3 carbon, while simple electronegativity considerations would predict a variation of the C–C′ bonds with substituents. The recent molecular structure determination of

TABLE I

C–C' Distances in derivatives of acetonitrile and methylacetylene

	C–C', A		C–C', A
Acetonitrile[5,6]	1·46	Methyl acetylene[4, 16]	1·46
Propionitrile[17]	1·47	Dimethyl acetylene[16, 18]	1·46
Pivalonitrile[19–21]	1·46	Dimethyl diacetylene[22, 23]	1·46
Trifluoroacetonitrile[5, 24]	1·465	Methyl iodo acetylene[25]	1·46
Trichloroacetonitrile[21, 26, 27]	1·465	Methyl bromo acetylene[25]	1·46
Malononitrile[28]	1·46	Trifluoromethyl acetylene[29]	1·46

malononitrile by Muller and Prichard[28] has shown that the C–C distance in this molecule is also 1·46 A. If π-bonding caused by hyperconjugation were important, each C–C bond in malononitrile should possess considerably less double bond character than in acetonitrile. So, it is concluded that the shortenings in the C–C bonds between sp and sp^3 carbon atoms (0·08 A) or sp^2 and sp^3 carbon atoms (0·04 A) may not result from any kind of conjugation and that it is likely that these bond contractions are almost entirely due to the changes in the covalent radius of carbon with hybridization. In fact, the distances discussed above fit in nicely with the Hertzberg-Stoicheff[30,31] classification of C–C distances. The bond lengths in relation to hyperconjugation have been discussed in fair detail by Sutton.[32]

The evidence for hyperconjugation from calorimetric data will no longer be valid since in these calculations, the change in the bond energy of the C–C bonds with bond lengths (with hybridization) was not taken into account. It appears obvious now that the C–C bond between sp and sp^3 or sp^2 and sp^3 carbon atoms must be stronger than the normal C–C bond between two sp^3 carbon atoms). So the effects attributed to hyperconjugation of the alkyl groups are really due to the introduction of a stronger C–C bond. Since these effects have not been taken into account in the current tables of bond energies and resonance energies, the values hitherto quoted are not correct. In general, the stabilization of an unsaturated system by alkyl substitution has been found to be essentially independent of the nature of the alkyl group and cannot be accounted for in terms of steric effects. As pointed out by Turner,[33] the calorimetric results do not provide significant information on the nature of the stabilization and cannot distinguish among the various possible interpretations.

The evidence for hyperconjugation from dipole moment data also needs reinterpretation. Since the electronegativity of an sp or sp^2 carbon is different from that of an sp^3 carbon, the resulting bonds (between any two differently hybridized carbon atoms) should have different polarity. In fact, recently Petro[34] has reported excellent agreement between the observed and calculated dipole moments of C–C bonds between two differently hybridized carbon atoms. Petro[34] concludes that hyperconjugation structures do not explain the non-zero dipole moment of toluene.

At this point, it may be worthwhile mentioning briefly a similar situation in the case of C–H bonds. The C–H bond length is dependent on the hybridization of the carbon atom.[7,35] The magnitudes of these changes have been accounted for by a study of the charge-cloud densities in the hybrid orbitals. Since a change in the electronegativity is always associated with a change in the atomic radius, C–H bonds of different types necessarily possess different polarities. From the available structural data, it is found that carbon-halogen distances are also very markedly affected by the change in the hybridization of the carbon. A possible explanation for all these observed bond shortenings is being attempted.[36]

The evidence for hyperconjugation on the basis of ionization potentials,[9,10] absorption spectra,[10–12] and chemical reactivity[10,13] is not foolproof because these deal with both the ground state and the excited (or transition) state of molecules. Further, the ionization potentials of the alkyl groups are found to be in the inductive order.[37] However, a simple molecular orbital treatment by Streitwieser and Nair[38] seems to indicate that the methyl group can be treated as a "heteroatom" donating two electron to the π system. The absorption spectral evidence has met with a number of objections.[37,39–42] Schubert and co-workers[41–43] propose an alternative explanation based on steric hindrance to solvation of the electron-deficient sites in the vicinity of the alkyl substituent. Arnold and co-workers[44] observe similar trends in the ultraviolet spectra of benzcycloalkenes and solvolysis rates of benzhydryl chlorides. The data seem to suggest the importance of

hyperconjugation and an explanation has been offered in terms of the Frank-Condon principle.

The chemical evidence for hyperconjugation has been a subject of controversy. The Baker-Nathan order, Me > Et > i–Pr > t–Bu, has been found in a number of reactions and has been explained in terms of C–H hyperconjugation.[10,45–47] The importance of C–C hyperconjugation in the *t*-butyl group has also been pointed out.[48] The relative importance of C–H and C–C hyperconjugation in aliphatic and aromatic series has been evaluated by Taft and co-workers[49,50] by application of the linear inductive energy relationship. Taft's method of evaluation of the magnitudes of hyperconjugation has been further illustrated by Baker.[51] McCaulay and Lien[44] have shown that C–H hyperconjugation must be an important mode of electron release in the methyl-substituted aromatic cations. de la Mare[53] has discussed the possibility of OH and NH hyperconjugation. Shiner,[54] Lewis[47] and Taft and co-workers[56] have shown that hyperconjugation is one of the important sources of secondary isotope effects.

Shiner[54] considers three possible effects on hyperconjugation: steric, substituent and solvent effects. Burawoy and Spinner,[57] however, do not consider the role of solvation and suggest that electron release by the alkyl groups is only by the inductive mechanism. Schubert and co-workers.[41,43] Baddely and Gorden[58] and Price and Blanger[59] prefer to discuss their results in terms of steric and solvent effects rather than hyperconjugation.

Berliner[60] is of the opinion that although the effect of the alkyl groups in individual reactions can be interpreted in different ways, hyperconjugation appears to be the most satisfactory general explanation for the behaviour of remote alkyl groups on the benzene ring where the Baker-Nathan order is observed.

From the discussion above it appears that any information from spectra or chemical reactivity regarding the possible role of hyperconjugation is not of much value since it is hard to distinguish such contributions in the ground state from that in the excited state of the molecule. All the physical evidence seem to rule out hyperconjugation in the ground state. These arguments have been forcefully expressed by Dewar and Schmeising,[61] who have developed a new method for calculating bond lengths and resonance energies for conjugated systems taking the σ-bond compression into consideration. They argue that if the π-electron resonance is unimportant in ordinary conjugation (as in the case of butadiene) it should be much more so in hyperconjugation. But Muller and Mulliken[62] and Mulliken[63] have found it desirable to explicitly classify conjugation and hyperconjugation into two types: isovalent and sacrificial (ordinary). They suggest further classification of isovalent conjugation and isovalent hyperconjugation into three sub-types: dative, non-dative and homodative, in order of increasing conjugative stabilization. Isovalent hyperconjugation has been suggested to be more important than ordinary hyperconjugation. The Baker-Nathan effect has been described as differential hyperconjugation. Apparently there are no theoretical reasons for expecting differences between C–C and C–H hyperconjugation.[63]

In conclusion the author feels that the present status of hyperconjugation may be summarized as follows: while the contribution from hyperconjugation seems unimportant in the ground state, it may or may not be prominent in the excited or the transition state.

The author has immensely benefited from the stimulating discussions he has had with Professors H. C. Brown, R. L. Livingston and N. Muller of Purdue University, Lafayette, Indiana, U.S.A. and Professor M. J. S. Dewar of Queen Mary College, London, England. He has taken complete advantage of the proceedings of the Conference on Hyperconjugation held at Indiana University, Bloomington, Indiana, U.S.A., in June 1958, in writing this article.

1. Mulliken, R. S., Reike, C. A. and Brown, W. G., *J. Am. Chem. Soc.*, 1941, **63**, 41.
2. —, *J. Chem. Phys.*, 1939, **7**, 339.
3. Keidel, F. A. and Bauer, S. H., *Ibid.*, 1956, **25**, 1218.
4. Trambarulo, R. and Gordy, W., *Ibid.*, 1950, **18**, 1613.
5. Danford, M. D. and Livingston, R. L., *J. Am. Chem. Soc.*, 1955, **77**, 2944.
6. Kessler, W., Ring, H., Trambarulo, R. and Gordy, W., *Phys. Rev.*, 1950, **79**, 54.
7. Coulson, C. A., *Valence*, Clarendon Press, Oxford, 1952.
8. Cullis, C. F., Hinshelwood and Mulcahy, M. F. R., *Proc. Roy. Soc.*, 1949, **196 A**, 160.
9. Mulliken, R. S., *Rev. Mod. Phys.*, 1942, **14**, 265.
10. Baker, J. W., *Hyperconjugation*, Oxford University Press, 1953.
11. Wheland, G. W., *Resonance in Organic Chemistry*, John Wiley and Sons, Inc., New York, 1955.
12. Matsen, F. A., Robertson, W. W. and Chuoke, R. L. *Chem. Revs.*, 1947, **41**, 273.
13. Baker, J. W. and Nathan, W. S., *J. Chem. Soc* 1935, 1844.
14. Crawford, V. A., *Quart. Revs.*, 1949, **3**, 226.

15. Becker, *Fortschr. Chem. Forch.*, 1955, **3**, 187.
16. Pauling, L., Springall, H. D. and Palmer, K. J., *J. Am. Chem. Soc.*, 1939, **61**, 927.
17. Lerner, R. G. and Dailey, B. P., *J. Chem. Phys.*, 1957, **26**, 678.
18. Pignataro, E. and Post, B., *Acta Cryst.* 1955, **8**, 672.
19. Livingston, R. L. and Rao, C. N. R., *J. Am. Chem. Soc.*, 1958., **81**.
20. Sparstad, T. and Amble, E., *J. Chem. Phys.*, 1957, **27**, 317.
21. Zeil, W. and Pfrommer, J. F., *Z. Elektrochem.*, 1957, **61**, 938.
22. Almenningen, A., Bastiansen , O. and Munthe-Kaas, T., *Acta Chem. Scand.*, 1956, **10**, 261.
23. Himes, R. C. and Harris, P. M., As referred to in Ref. 22.
24. Thomas, L. E., Heeks, J. S. and Sheridan, J., *Z. Elektrochem.*, 1957, **61**, 935.
25. Sheridan, J. and Gordy, W., *J. Chem. Phys.*, 1952, **20**, 735.
26. Livingston, R. L., Rao, C. N. R. and Page, W. E., Unpublished Results.
27. Baker, J. G., Jenkins, D. R., Kenney, C. N. and Sugden, T. M., *Trans. Faraday Soc.*, 1957, **53**, 1397.
28. Muller, N. and Prichard, D. E., *J. Am. Chem. Soc.*, 1958, **80**, 3483.
29. Shoolery, J. N., Shulman, R. G., Sheehan, W. F., Jr., Schomaker, V. and Yost, D. M., *J. Chem. Phys.*, 1951, **19**, 1364.
30. Herzberg, G. and Stoicheff, B. P., *Nature*, 1955, **175**, 79.
31. Stoicheff, B. P., *Curr. Sci.*, 1958, **27**, 1.
32. Sutton, L. E., *Tetrahedron*, 1959, **5**, 118.
33. Turner, R. B.. *Ibid.*, 1959, **5**, 127.
34. Petro, A. J., *J. Am. Chem. Soc.*, 1958, **80**, 4230.
35. Walsh. A. D., *Trans. Faraday Soc.*, 1947, **43**, 60.
36. Rao, C. N. R., To be Published.
37. Hammond, V. J., Price, W. C., Teegan, J. P. and Walsh, A. D , *Discussions Faraday Soc.*, 1950, **9**, 53.
38. Streitwieser, A., Jr. and Nair, P. M., *Tetrahedron*, 1959, **5**, 149.
39. Platt, J. R. and Klevens, H. B., *Chem. Revs.*, 1947, **41**, 301.
40. Bowden, K. and Braude, E. A., *J. Chem. Soc.*, 1952, 1068.
41. Schubert, W. M. and Sweeney, W. A., *J. Org. Chem.*, 1956, **21**, 119.
42. —, Robins, J. and Haun, J. L., *J. Am. Chem. Soc.*, 1957 **79**, 910.
43. —, Craven, J. M., Minton, R. G. and Murphy, R. B., *Tetrahedron*, 1959, **5**, 194.
44. Moore, W. R., Marcus, E., Fenton, S. F. and Arnold, R. T., *Ibid.*, 1959, **5**, 179.
45. Huges, E. D., Ingold, C. K. and Taher, N. A., *J. Chem. Soc.*, 1940, 950.
46. de la Mare, P. B. D. and Robertson, P. W., *Ibid.*, 1943, 279.
47. Berliner, E and Co-workers, *J. Am. Chem. Soc.*, 1946, **68**, 2355; *Ibid.*, 1949. **71**, 1195; *Ibid.*, 1950, **72**. 222; *Ibid.*, 1954, **76**, 6179.
48. Brown, H. C., Brady, J. D., Grayson, M. and Bonner, W. H., *Ibid.*, 1957, **79**, 1897.
49. Kreevoy, M. M. and Taft, R. W. Jr., *Ibid.*, 1955, **77**, 5590.
50. Taft, R. W. Jr. and Lewis, I. C., *Tetrahedron*, 1959, **5**, 210.
51. Baker, J. W., *Ibid.*. 1959, **5**, 135.
52. McCaulay, D. C. and Lien, A. P., *Ibid.*. 1959, **5**, 186.
53. de la Mare, P. B. D., *Ibid.* 1959, **5**. 107.
54. Shiner, V. J. Jr , *Ibid.*, 1959, **5**, 243.
55. Lewis, E. S , *Ibid.*, 1959, **5**, 143.
56. Love, P., Taft, R. W. Jr. and Wartik, T., *Ibid.*, 1959, **5**, 116.
57. Burawoy, A and Spinner, E., *J. Chem. Soc.*, 1954, 3752; *Ibid.*, 1955, 2557.
58. Baddeley, G. and Gordon, J., *Ibid.*, 1952, 2190.
59. Price, C. C. and Blanger, W. J., *J. Am. Chem. Soc.*, 1954, **76**, 2682.
60. Berliner, E., *Tetrahedron*, 1959, **5**, 202.
61. Dewar, M. J. S. and Schmeising, H. N., *Ibid.*, 1959, **5**, 166.
62. Muller, N. and Mulliken, R. S., *J. Am. Chem. Soc.*, 1958, **80**, 3489.
63. Mulliken, R. S., *Tetrahedron*, 1959, **5**, 253.

INTERNATIONAL ATOMIC ENERGY AGENCY AS INFORMATION CENTRE FOR FUSION RESEARCH

THE Scientific Advisory Committee of the International Atomic Energy Agency which met in Vienna on 4-6 June, 1959, has made a strong recommendation that the Agency should become the world focal point for the exchange of information on progress in the field of controlled fusion and plasma physics.

The Committee advised the Director-General to initiate an international scientific journal on progress in thermonuclear fusion research. Such a journal would appear quarterly and carry technical papers on developments to all Member States engaged in such work and make the information available to the world scientific comm unity. The Director-General was also asked to make arrangements for the convening of international scientific conferences on plasma physics and controlled fusion.

Much information in this field was made public during the Second United Nations Scientific Conference on the Peaceful Uses ot Atomic Energy, Geneva, September 1958. That Conference gave the impetus to further intensified research on fusion and developments in this sector of research are taking place rapidly in many countries. The Scientific Advisory Committee was of the opinion that it would be most useful if efforts could be directed in the most promising directions and worldwide co-operation could be initiated. The International Agency would, in the Committee's view, be the logical and most suitable agent to assume this important role.

The Seven-Member Advisory Committee includes Dr. H. J. Bhabha, Chairman of the Indian Atomic Energy Commission, Sir John Cockcroft from the United Kingdom, Prof. Emolyanov from the Soviet Union and Prof. Rabi from the United States.

ARTIFICIAL CLIMATE STATION FOR PLANT RESEARCH*

THE Artificial Climate Station of the Institute of Plant Physiology, Moscow, is so fitted that every room and every laboratory here has its own particular climate, soil, illumination and air-conditioning, thus helping scientists to study the laws governing the life of plant organisms in any part of the terrestrial globe. It is adapted for investigations to be carried on not only to ascertain the laws of growth and development of plants, but also to study their resistance to unfavourable external conditions, such as frosts, droughts, saline soils, etc.

There are special chambers at the Station for work at low temperatures. Any desired degree of cold can be produced in them, including the very lowest that exist on earth, as — 80° C. Thermoregulators constantly fix the temperature within these chambers and the slightest deviation from the given conditions is eliminated automatically. These chambers also have electric stoves. When they are switched on frozen plants begin to thaw. In the cold rooms observations are made of the winter-resisting ability of plants — spring, autumn and subtropical crops, fruit cultures and forest species. Many experiments have shown that the frost-resisting ability of plants in spring and autumn is low, but that it rises in winter.

It is known that plants cannot hold out in a frost that has set in unexpectedly, say, in the middle of summer ; they perish, including even such cold-resisting trees as the birch and pine. Yet during the winter they withstand frosts of — 60° C. The reason for this has been investigated by the workers at the centre who are engaged in breeding frost-resisting varieties of plants.

An understanding of the nature of the very process of the freezing of a plant has proved a decisive factor in solving this riddle. It was discovered that this process begins with the formation of an icy crust on the outer cell wall. As the cooling continues, the icy crust spreads to the nourishing juices which are inside the cell, and that leads to its severance and ruin. Such is the case when there are sudden frosts in spring or summer, at a time when the plants are in the process of growing and their cells are full of juices.

But under usual conditions the cell struggles very "cleverly" for its existence. It tries to rid itself of its water and its nourishing juices before the frosts set in. This process begins in autumn. The cells, when cooling gradually, throw off their nourishing juices into intercellular space, where they "winter".

The following interesting experiment was performed at the Station. Autumnal conditions were artificially created for black currant at the beginning of summer. The day was shortened, the solar light was weakened, and the temperature of the soil and air was lowered. The plant, which had not as yet borne fruit, prepared to defend itself against the frost : it dropped its yellowed leaves, and cut down on the amount of juices it consumed. Following this the plant withstood a test not only of — 80° C. but even cooling to — 200° C. in liquid nitrogen. Yet at the same time the berries on a control black current bush ripened.

At the Station there is a so-called "light little yard" with an extensible roof. Here during good weather, the plants are out in the open, and in bad weather they are well protected from the wind and rain. But the most interesting thing in this little yard are the thermostats beneath the roots. At first glance their designs seem rather simple. They are tanks filled with brine. Each such tank, into which 20 vegetal vessels are submerged, is automatically heated by an electric heater or cooled by a cooling apparatus. The roots of the plants which are in them are cooled or heated accordingly.

The observations that have been made have enabled the scientists definitely to establish why, for example, when the temperature of the soil is high the tubers of potatoes degenerate, whereas the lemon tree, on the contrary, greatly hastens its growth and fruiting.

As has been discovered when the temperature of the soil is high, the juice-bearing capillaries in the potato tops greatly expand, and this phenomenon is accompanied by a "feverish" rise in the metabolism of that part of the plant which is on the ground. The potato tops begin to grow luxuriantly, feeding themselves at the expense of the tubers by sucking up their juices. With the lemon, on the contrary, in-

* Through the courtesy of USSR Embassy in India.

cool soil we notice "sclerosis" of the capillaries of the root system and branches of the tree As a result of these investigations it is recommended that in hot countries potatoes be planted not in spring but in summer, so that they will grow and ripen in autumn.

BACTERIA AND INSECTS: HOST-PARASITE RELATIONSHIPS

IN 1915, the German bacteriologist, Berliner, isolated from the diseased larvæ of the meal moth, *Ephestia kuhniella*, an aerobic, rod-shaped, spore-forming bacterium, which he showed to be the cause of the disease. A careful study of this bacterium, which he called *Bacillus thuringiensis*, revealed something unusual. As a culture, growing on a nutrient agar plate, became old the vegetative bacterial cells began to produce spores in the usual way; but, instead of the rest of the cell contents gradually disappearing until only the spore was left, as would normally happen with a spore-forming bacterium, a second body developed within the bacterial cell alongside the spore. What was even more surprising was that this body assumed a regular rhomboidal shape.

No one really took much notice of this structure until, in 1956, Hannay in Canada rediscovered it and proved by chemical analysis the rhomboidal granules to be protein crystals. Did these crystals play any part in the disease process?

In 1902 Japanese workers isolated an aerobic, spore-forming bacillus from diseased silkworms and called it *B. sotto*. They showed that it produced a toxin which affected the silkworms and which was associated not with young vegetative cells but with old, well sporulated, cultures. A new study of strains of *B. sotto* showed that it, too, produced protein crystals. Did these crystals have any connection with the toxin? The answer came in 1954 from Angus, also working in Canada.

Angus took an old culture of *B. sotto* and extracted it with silkworm gut juice. He then removed the spores by filtration and showed that the fluid left contained a substance which, when fed to larvæ, caused paralysis and death. The gut contents of these larvæ are very alkaline and it can easily be shown that the protein crystals go into solution in dilute alkali. Angus then separated crystal protein from spores and tried the effects of feeding and injecting various fractions.

When an old culture consisting of spores and crystals was fed to the larvæ there was first a paralysis and then the bacteria passed through the gut wall into the body cavity to produce a septicæmia. If the same culture was injected directly into the body cavity bacteria multiplied there to give a septicæmia—but there was no paralysis. When spores alone were fed there was no invasion of the body cavity but septicæmia developed if they were injected directly into the body cavity. Crystal protein by itself caused paralysis on feeding but not on injection. It seems that: (1) Crystal protein is necessary for the penetration of the bacterium through the gut wall. (2) The protein needs to be activated by the gut juice before it becomes toxic.

Here then we have an interesting, complicated, not yet fully understood, host-parasite relationship.

B. thuringiensis, *B. sotto* and a few other bacteria producing disease in various insects are all very similar to one another and, as a group, bear a striking resemblance to a common saprophytic bacterium *B. cereus*, which abounds in soil, dust and other natural environments. The only real difference between the insect pathogens and *B. cereus* is that *B. cereus* fails to produce protein crystals and is of course incapable of causing disease.

So close is the similarity that we might well ask, "Could it be that the insect pathogens represent strains of the saprophyte which have in some way become adapted to a parasitic —and indeed pathogenic—mode of life?" This adaptation would of course involve the development of the ability to synthesise this peculiar crystalline protein. This is the crux of the whole matter. If, in the laboratory, we could take strains of the saprophyte and, by subjecting them to suitable conditions, render them pathogenic and capable of crystal synthesis we should be a big step nearer to understanding some of the mechanisms underlying the parasitic mode of life of these bacteria and to understanding the factors which led to the development of the parasitic habit. We should indeed be cultivating fields of knowledge about which we know very little.—*From a paper contributed by Dr. J. R. Norris to the Glasgow Meeting of the British Association.*

LETTERS TO THE EDITOR

FADING OF SHORT-WAVE RADIO SIGNALS

THIS note gives the results of some observations on the fading of radio-waves as observed at Nagpur from the stations listed in Table I. Readings were taken in the evening and during the late hours of the night. Sometimes the observations were also recorded in the morning hours and during daytime. The apparatus used for detecting the waves was a B.C. 348 Q receiver in which the A.V.C. was removed and the voltage developed across the second detector was amplified by a D.C. amplifier and measured in an A.V.O. Electronic Testmeter. The antenna used was a hollow metallic vertical rod of length 136 cm. and diameter 0·67 cm. The readings in the metre for various positions of M.V.C. were calibrated with a standard G.R. Signal Generator. The calibration curves were linear except for low and high input voltages. The error involved in taking the visual observations was less than 3% in all cases.

Sometimes the fading patterns were recorded on an Esterline-Angus Recording D.C. Milliammeter.

TABLE I

Stations and their frequencies

Station		Freqnency (evening) Kc./s.	Frequency (morning) Kc./s.
Vividh Bharati Madras	..	9735	11950·5
do. Bombay	..	9550	11900·0
Radio Ceylon	..	7190	9520
do.	..	11770	15120
Radio Australia	..	7220	..
do.	..	9580	..
do.	..	11710	..
Bombay	..	7240	7240
Calcutta	..	7210	7210
Madras	..	4920	..
Delhi	..	4960	..

In the case of the Vividh Bharati transmissions the fading patterns after sunset were mostly periodic on which random variations were superposed (see Fig. 1). The interval between the two successive crosses is 15 seconds. On the same wave band and at the same time for Radio Australia (9580 Kc./s.) such patterns were not observed. Further for Calcutta (7210 Kc./s.) and Bombay (7240 Kc./s.), the fading patterns after sunset were also of a quasi-periodic nature. While for Radio Ceylon (7190 Kc./s.) in the same wave band and for Madras (4920 Kc./s.) and Delhi (4960 Kc./s.) such patterns were not so pronounced. These

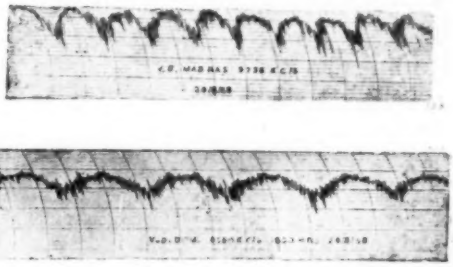


FIG. 1

patterns were not observed during the night hours.

The chief characteristics of the patterns are

(i) The interval between the two successive maxima or minima varies from 20 to 60 seconds. The most common value is around 40 seconds.

(ii) Their ratio changes from 1·5 to 3·0 as seen from Figs. 1 and 2.

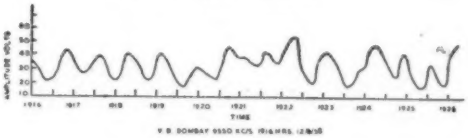


FIG. 2

Fading of radio-waves of the type recorded here is well known. Appleton and Beynon[1] have shown that periodic fading in the morning and evening hours is due to the interference between the two magneto-ionic split components (ordinary and extraordinary) of comparable amplitudes. Banerjee and Singh[2] also reported periodic fading patterns under conditions of high ionospheric ionisation. Khastgir and Das[3] attributed this fading to Doppler beat phenomena between the two waves either singly and doubly reflected from the same layer or singly reflected from two different layers moving with the same vertical velocity. While N. V. Gurunadha Sarma[4] has taken into account the different vertical velocities for E and F_2 layers.

The fact that such patterns are observed during the evening hours suggests that it may be in some way connected with the process in

which the F_1 layer combines with F_2 layer to form a single F layer. The special feature to be noted is that these patterns are not observed for all the stations, nor do all the stations in the same wave band give such patterns. This suggests that some relation exists between the occurrence of these patterns and the frequency of transmission, distance between the transmitter and the receiver and their location.

Most of the random looking patterns are analysed in the light of the Rayleigh Probability distribution formula for random scattering,

$$P = \frac{A}{R^2} e^{-A^2/2R^2}$$

where P dA is the probability that the amplitude will lie between A and A + dA, R^2 is the sum of the squares of components of random phases. The procedure adopted to plot experimental and Rayleigh curves is similar to the one used by Khastgir and Ray.[5] A small number of observations agree with this formula. Some of the curves of agreement and disagreement are shown in Figs. 3 and 4. The Rayleigh Law is

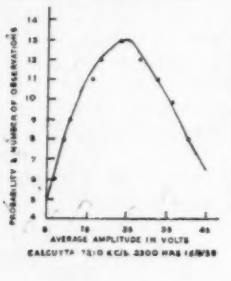


FIG. 3

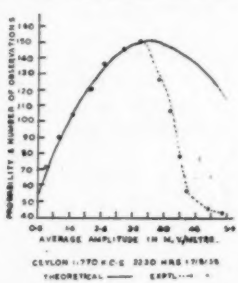


FIG 4

valid for only one downcoming wave.

A detailed account of the above work will be published elsewhere.

The author is indebted to Prof. K. R. Dixit, for his kind interest and guidance during the progress of the work. Thanks are also due to Prof. Shahane, Dr. Kher and Shri Khandekar of the Department of Physics for their kind help during the progress of the work.

Department of Physics, V. L. LOKRE.
College of Science,
Nagpur, *November* 13, 1958.

1. Appleton and Beynon, *Proc. Phys. Soc.*, 1947, **58**, 59.
2. Banerjee and Singh, *Ind. J. Phys.*, 1948, **22**, 413.
3. Khastgir and Das, *Proc. Phys. Soc.*, 1950, **63**, 924.
4. Gurunadha Sarma, N. V., *Curr. Sci.*, 1955, **24**, 190–91.
5. Khastgir and Ray, *Ind. J. Phys.*, 1940, **30**, 282.

VARIATION OF RELAXATION TIME WITH VISCOSITY—BENZYL ALCOHOL AND NITROBENZENE

RESULTS of a study of the variation of dielectric relaxation time with viscosity of the solvent in the case of two molecules, Benzyl alcohol and Nitrobenzene are reported in this article. Carbon disulphide is used as the solvent and the viscosity is varied by mixing varying amounts of medicinal paraffin. Measurements of dielectric constant and loss factor are made on a wave-guide set up at 3·20 cm. using the standing wave method of Roberts and von Hippel.[1] The method of computing the relaxation time τ and dipole moment μ is the same as the one developed by Radhakrishnamurty and Narasimha Rao.[2] The final results are presented in Table I.

TABLE I

Solute	Solvent	Percentage Paraffin	Solvent viscosity	Apparent $\tau \times 10^{12}$ sec.	Apparent μ D.
Benzyl alcohol ..	CS_2 + Paraffin	0	0·34 centi-poise	7·5	1·4
		20	0·49	9·4	1·2
		40	0·78	9·5	1·2
		60	3·89	4·4	1·0
Nitrobenzene ..		10	0·45	7·9	4·3
		25	0·58	8·3	3·6
		40	0·78	9·4	4·9
		60	3·89	8·2	2·4
		88	90·00	13·1	2·2

It is interesting to note that (1) in the case of Benzyl alcohol τ goes through a maximum as the viscosity of the solvent is increased and (2) the calculated dipole moment decreases as the solvent viscosity is increased in both the cases. These may be due to the fact that the Debye equations are not valid for the higher viscosity solvents. Similar observations were reported by Whiffen and Thompson[3] also.

The author wishes to express his indebtedness to Prof. K. R. Rao for suggesting the problem and for his continued interest.

Physics Department, R. RAJAN.*
Andhra University,
Waltair, *March* 10, 1959.

* Present Address: Department of Physics, Indian Institute of Science, Bangalore.

1. Roberts, S. and von Hippel, A. R., *J. Appl. Phys.*, 1946, **17**, 610.
2. Radhakrishnamurty, Ch. and Narasimha Rao, D. V. G. L., *J. Sci. Ind. Res.*, 1956, **15B**, 346.
3. Whiffen, D. H. and Thompson, H. W., *Trans. Farad. Soc.*, 1946, **42A**, 114.

PROPAGATION OF GROUND WAVES ACROSS A LAND/SEA BOUNDARY

With the introduction of radio aids to navigation the understanding of the directional errors introduced when the radio waves cross the land/sea or sea/land boundary became essential. Millington[1] discussed the problem of ground wave transmission across land/sea boundary and predicted that there should be a marked recovery of field strength. On medium wavelengths this recovery should extend to considerable distance over sea. Subsequently Elson[2] conducted experiments with 267 metre waves and his results demonstrate clearly the occurrence of recovery effect on passing from land to sea at medium wavelengths and thus confirming in general outline the prediction of Millington.[1] Our observations on the field strength of ground waves of 447·9 metres wavelength from A.I.R. Calcutta station suggest that such a recovery of field strength as expected from Millington's analysis is possible even at these wavelengths. A weak ground wave signal is received here from Calcutta which is 1370 km. away from this place, a part of this transmission path, about 650 km., being over the sea. In view of this large distance no ground wave is expected here, even after taking into consideration the relatively lower attenuation suffered by the wave over the sea path. This can be explained on the basis of Millington's theory.[1]

Table I

Station	Distance (km.)	Wave-length (metres)	Power (K.W.)	Relative intensities	
				Theoretical	Experimental
Madras B ..	110	211·3	1	1·0	1·0
Madras A ..	110	319·1	20	17·8	19·0
Bangalore ..	205	491·8	10	10·0	8·4
Tiruchi ..	330	389·6	5	1·2	0·9
Vijayawada	340	357·1	20	2·17	1·92
Hyderabad	410	405·4	5	0·02	0·022
Calcutta A	1370	447·8	50	0·0008	0·015

In Table I are given the relative intensities of the ground waves received at Tirupati taking the intensity of the ground waves from Madras B transmitter of I.K.W. power as unity. The theoretical values of the relative intesities of the ground waves received at Tirupati from various medium wave stations are obtained from the field strength—distance curves of Terman.[3] The field strength for Calcutta station has been arrived at by considering the attenuation suffered by the wave on the land and the sea-paths separately.

There is good agreement between the experimental and the theoretical values of the relative intensities for all stations excepting Calcutta. The field strength observed at Tirupati has definitely indicated a higher value than that expected. This unusual reception can be understood from a consideration of the path along which the ground waves from Calcutta reach this receiving centre. This is a case of transmission over a composite path which consists of both land and sea. Applying Millington's analysis to the case of transmission across the land/sea boundary we expect the field strength of the wave to rise above the land value at the land/sea boundary. Since the recovery which develops into a maximum extends to a considerable distance over the sea, a section of the sea-path has been traversed by the wave without suffering any alteration over the land value, but instead with a gain in field strength. The rest of the sea-path is traversed with an attenuation characteristic of the sea-water. Thus the wave reaches the sea/land boundary with a field strength which is not far lower than that at the land/sea boundary. When the waves cross the sea/land boundary there will be a rapid attenuation of the wave. On the whole sufficient intensity can be expected at Tirupati to account for the reception of these ground wave signals.

The details regarding the extent of recovery and the field strength expected here on the basis of Millington's theory are being worked out and will be published in due course.

Physics Department, P. Venkateswarlu.
S.V. University, R. Satyanarayana.
Tirupati, *April* 27, 1959.

1. Millington, G., *Proc. I.E.E.* (*Lond.*), 1949, **96**, Pt. III, 53.
2. Elson, N., *Nature*, 1949, **164**, 115.
3. Terman, F. E., *Radio Engineering*, McGraw Hill Book Co., Inc., 1947, p. 613.

ORIENTED CRYSTALLISATION OF INORGANIC SALTS ON FEATHER KERATIN

It was reported that under certain conditions epitaxial growth of inorganic salts could be induced to take place on collagen.[1] A detailed study of the phenomenon revealed that the well known conditions controlling epitaxial growth on crystalline substrates were valid for fibrous substances also.[2,3] The study was extended on a smaller scale to other fibrous proteins like feather, hair and silk. The experiments

conducted with feather keratin are described in this note.

Pieces of swan feather rachis were cut and washed well in distilled water. They were placed in alkaline solutions of a number of inorganic salts. The pH of the solutions was varied by dissolving different amounts of the salt in a definite volume of normal sodium hydroxide. After about 16 hours they were removed and dried. X-ray diffraction photographs of the specimens were then recorded as usual in conventional cameras using Cu K_α radiation.

The action of alkali on the feather depended on the concentration. In highly alkaline solutions the substance was found to disperse while in neutral solutions no change was observed. Some of the fibres assumed a yellow tint and became somewhat soft to the touch. As a typical case the action of sodium tartrate on feather is given in Table I.

TABLE I

Specimen No.	Amount of salt	Vol. of N. Sod. hydroxide	External change of the fibre	Degree of orientation
	(g.)	(c.c.)		
1	1·0	5	No change	Good
2	0·75	5	Soft	Coarse powder rings
3	0·50	5	Sheath dispersed	Coarse powder rings
4	0·25	5	Transparent jelly	..
5	1·00	Neutral	No change	No deposition

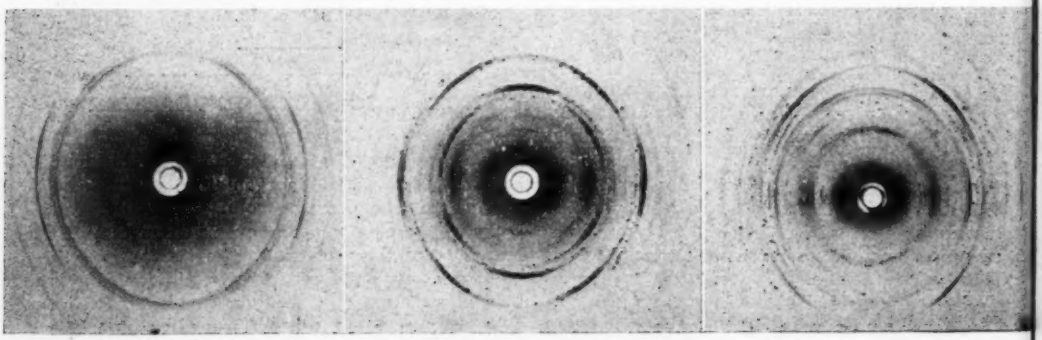
The X-ray diagram recorded with specimen No. 1 exhibited extended reflexions due to sodium tartrate arranged along layer lines. In addition to these reflexions coarse powder rings of the substance were also found to occur. The latter vanished when the surface of the specimen was scraped well with a blade. The X-ray diagram recorded with the scraped specimen in cylindrical camera (diameter 57·3 mm.) is reproduced in Fig. 1.

Similar experiments were carried out with sodium sulphate. Partially oriented deposits of sodium sulphate III was found to occur on the fibres with its c parameter aligned along fibre axis (Fig. 2). In one instance, the deposit was identified to be sodium carbonate monohydrate, occurring with the b parameter lying along fibre axis (Fig. 3). Probably this substance must have been formed in the solution by the action of atmospheric carbon dioxide on alkali. The X-ray diagrams have been recorded in a 3 cm. cylindrical camera. A number of other salts were also tried but in their case the orientation was very poor. The results are presented in Table II.

TABLE II

No.	Salt	Nature of deposit as revealed by X-ray diagram
1	Sodium tartrate	.. Good orientation
2	Sodium sulphate III	.. Poor ,,
3	Sodium carbonate, monohydrate	Good ,,
4	Sodium chloride	.. Coarse powder lines
5	Sodium bicarbonate	.. No deposition
6	Potassium chloride	.. Coarse powder lines
7	Potassium sulphate	.. Powder lines due to potassium carbonate hydrate along with those of K_2SO_4
8	Potassium nitrate	.. Coarse powder lines

It is interesting to note that in the case of collagen also the first three salts gave best results while orientation of potassium salts were generally poor. Recent X-ray studies conducted in this laboratory indicate that there



1 2 3

is considerable structural resemblance between feather keratin and collagen.[4] The structure is believed to be a super-helix composed of triple helical ropes. In the small angle region various orders of a spacing of 95 A occur corresponding to the 640 A in collagen. In view of the close similarity between the molecular structure of collagen and feather keratin, it is not surprising that the phenomenon of oriented crystallisation occurs also under similar conditions in the two cases.

Dept. of Physics,
University of Madras, G. K. AMBADY.*
Madras-25, *April* 29, 1959.

* Present address—"ATIRA", Ahmedabad.

1. Ramachandran, G. N. and Ambady, G. K., *Experientia*. 1955, **11**, 343.
2. Van Der Merwe, J. H., *General Discussion on Crystal Growth, Faraday Soc.*, 1949, No. **5**, 201.
3. Ambady, G. K., *Proc. Ind. Acad. Sci.*, 1959, **49**, 136.
4. Ramachandran, G. N., *Acta Cryst.*, 1957, **10**, 816.

AN INVESTIGATION ON THE REACTION BETWEEN BERYLLIUM SULPHATE AND OXINE

KOLTHOFF and Sandell[1] reported complete separation of aluminium from beryllium by the addition of oxine in the presence of acetic acid and ammonium acetate. Neissner[2] observed that complete separation of aluminium (together with iron and copper) from beryllium was possible, since, according to him, beryllium formed no complex with oxine. However, it is mentioned in the literature[3,4] that a product of indefinite composition is obtained when a solution containing beryllium ions and oxine is made alkaline with ammonia. It, therefore, appears that no attempt has been made to determine the actual nature of the compound that is formed, if any, between beryllium and oxine. The results of this reaction by spectrophotometric method are briefly discussed here.

An aqueous solution of beryllium sulphate and an alcoholic solution of oxine were employed. Alcoholic solution of oxine was colourless and showed negligible absorption in the visible region, while the aqueous solution of oxine, prepared by means of acetic acid, was coloured yellow and showed appreciable absorption. Therefore alcoholic solution of oxine was preferred to the aqueous solution. Aqueous solution of beryllium sulphate (M/10), which was colourless and showed no absorption in the visible region, and alcoholic solution of oxine when brought together to interact in different proportions produced light yellow to greenish yellow colour depending on the concentration of beryllium. A mixture of beryllium sulphate and excess of oxine showed maximum absorption at 410 mμ indicating thereby the formation of a complex. The composition of the complex formed was determined by Job's continuous variation method,[5] by taking M/10 solution each of beryllium sulphate and oxine, at 450, 480, 500 and 550 mμ and the same experiment was repeated with M/20 and M/30 each of beryllium sulphate and oxine. In all the cases the maxima in the curve between optical density and concentration were obtained at the ratio 1 : 2 of beryllium sulphate to oxine. This ratio determines the composition of the complex and its formation may be represented by the equation, $BeSO_4 + 2C_9H_6NOH \longrightarrow Be(C_9H_6NO)_2 + H_2SO_4$. That sulphuric acid is one of the products of reaction was ascertained by the pH data obtained. With the formation of the complex the pH of the solution attained a value of the order of 4·5.

The dissociation constant of the complex was determined by Job's method at 480 and 500 mμ for four different concentrations, namely, M/10 solution of beryllium sulphate with M/4, M/5, M/15, M/20 solutions of oxine. The average value of the dissociation constant K was $2{\cdot}35 \times 10^{-3}$.

Detailed results of this investigation will be published later.

The authors express their grateful thanks to Prof. A. K. Bhattacharya for his kind interest in this work.

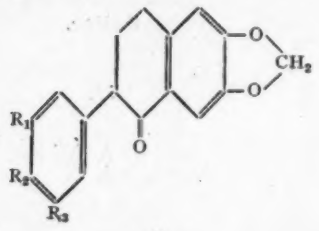
ARUN K. BHATTACHARYA.
G. S. RAO.
Department of Chemistry,
University of Saugar,
Sagar M.P., *January* 17, 1959.

1. Kolthoff and Sandell, *J. Amer. Chem. Soc.*, 1928, **50**, 1900.
2. Neissner, *Z. Annal. Chem.*, 1929, **76**, 135.
3. Hollingshead, *Oxine and its Derivatives*—Butterworth's Scientific Publications, London, **3** (1), 111.
4. Flagg, "*Chemical Analysis—Vol. IV,—Organic Reagents in Gravimetric and Volumetric Analysis*, Interscience Publishers Inc., New York, 1948, 184.
5. Job, *Ann. Chem.*, 1928, **9**, 113.

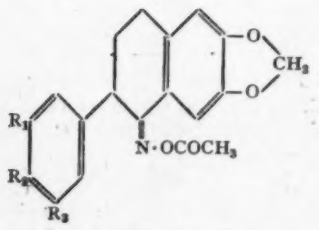
A NOVEL DEHYDROGENATION-CYCLISATION REACTION OF 2-ARYL-1-TETRALONE OXIME ACETATES

IN connection with synthetic work on certain alkaloids of the 1 : 2-benzphenanthridine group, we had occasion to study the aromatisation of some substituted 2-aryl-1-tetralone oxime acetates by the Schroeter reaction. This

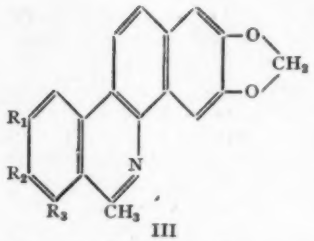
reaction was originally employed by Schroeter[1] for converting 1-tetralones to 1-naphthylamines. Recently Mills and Schofield[2] have extended this method for the conversion of 1-aryl-2-tetralones to 2-diacetylamino-1-arylnaphthalenes. In our study, 2-(3 : 4-dimethoxyphenyl)-, 2-(3 : 4-methylenedioxyphenyl)-, and 2-(3-methoxy-4 : 5-methylenedioxyphenyl)-1 : 2 : 3 : 4-tetrahydro-1-keto-6 : 7-methylenedioxynaphthalenes (I *a*, I *b*, and I c) were prepared by the Richardson-Robinson-Seijo method[3] and converted into the respective oxime acetates (II *a*, II *b* and II c). These were then subjected to the Schroeter reaction by heating with acetic anhydride, acetic acid and hydrogen chloride in a sealed tube at 95-100°. Whereas the normal products of the reaction are the naphthylamines or their acetyl derivatives, we obtained directly in good yields the corresponding 1 : 2-benzphenanthridines : 6 : 7-dimethoxy-9-methyl-2′-3′-methylenedioxy-1 : 2-benzphenanthridine (III *a*), m.p. 233°, $\lambda_{max.}$ 230, 275, 350, 365 mμ (log ϵ 4·50, 4·94, 3·67, 3·36) ; 9-methyl-6 : 7 : 2′ : 3′-bismethylenedioxy-1 : 2-benzphenanthridine (III b), m.p. 299°, $\lambda_{max.}$ 230, 275, 350, 365 mμ (log ϵ 4·35, 4·70, 3·55, 3·35) ; and, in the third case, a mixture of 1 : 2-benzphenanthridines (III c and III d) of which only one isomer, m.p. 260°, $\lambda_{max.}$ 220, 280 ,320, 370 mμ (log ϵ 4·31, 4·65, 4·18, 3·14), could be isolated in a pure state. The benzphenanthridines are obviously formed by the spontaneous cyclisation of the intermediate acyl derivatives under the acidic reaction conditions. These represent instances of Morgan-Walls cyclisation proceeding without the use of conventional cyclisation reagents.[4]



I



II



III

(*a*) $R_1=R_2=OCH_3$; $R_3=H$
(*b*) $R_1R_2=-O.CH_2.O-$; $R_3=H$
(*c*) $R_1=OCH_3$; $R_2R_3=-O.CH_2.O-$
(*d*) $R_1R_2=-O.CH_2.O-$; $R_3=OCH_3$.

One of us (K.W.G.) thanks the Government of India for the award of a National Research Fellowship.

Dept. of Chemistry, Presidency College, Madras,
K. W. GOPINATH.
T. R. GOVINDACHARI.
N. VISWANATHAN.

March 10, 1959.

1. Schroeter, G., *Ber.*, 1930, **63 B**, 1308.
2. Mills, B. and Schofield, K., *J. Chem. Soc.*, 1956, 4213.
3. Richardson, T., Robinson, R. and Seijo, E., *Ibid.*, 1937, 835.
4. Theobald, R. S. and Schofield, K., *Chem. Rev.*, 1950, **46**, 175.

REPLACEMENT DYKES IN THE MIGMATITES OF YELLANDLAPAD

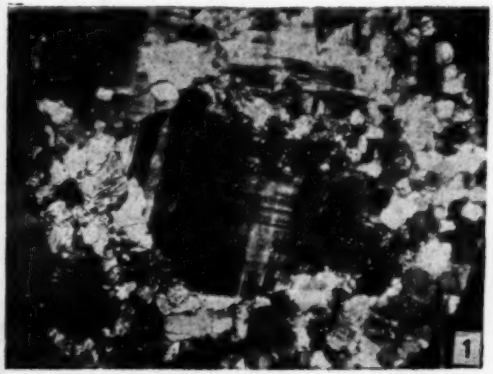
DISCUSSING the Granite-Pakhal relationship of Yellandlapad area in an earlier paper the author[1] suggested that the rocks are dominantly migmatitic with only subordinate granite and that the latter are formed due to the granitization of Pakhals in anticlinal cores. During the course of a detailed field examination of the same area, the author noticed at a few places the occurrence of quartzo-felspathic dykes and veins in very fine-grained dark looking rocks which are found as enclaves in the migmatites of the area. The dykes are exactly like the magmatic granite in appearance consisting of coarse grained white felspars and quartz with a little mafics here and there. Their contact with the gneiss, though sharp in outline, on closer examination is found to be much wavy and irregular.

In the microscopic study, the contact between the leucocratic dyke and the host rock loses its identity. The mineralogical and textural features of the host rock, contact zone and the

dyke are clearly revealed in the photo-micrograph. The host rock is seen to consist of pseudo-cataclastic quartz and lot of greenish-brown biotite showing parallel arrangement of clusters and a good amount of oligoclase. The accessories are apatite and magnetite. All these form a ground mass in which are embedded somewhat bigger grains of plagioclase. These features of host rock persist through the contact into the dyke, the only conspicuous difference in the dyke being a decrease in the biotite content and a new development of potash felspar porphyroblasts which include both orthoclase and microcline. While the plagioclase of the ground mass is intensely sericitized and dirty, the microcline areas are remarkably clear. The potash felspar invariably shows corroded margins and it is no doubt growing at the expense of the ground mass as clearly observed in the photo-micrograph (Fig. 1). Myrmekitic intergrowths are frequently noticed at the junction between ground mass and microcline porphyroblasts. It is noticed that myrmekite is merely a transitional stage in the conversion of plagioclase to microcline, an observation which has been recorded by Cheng[2] and many others in recent years. This fact is further corroborated by the presence of both myrmekite and plagioclase as inclusions in microcline in various stages of 'digestion' by potash felspar. Another very interesting observation is that the so-called contact between the dyke and the host rock is marked by a zone of biotite enrichment, suggesting a small-scale basic front. Such features have been reported by Goodspeed,[3] King,[4] Ramberg[5] and others. Microscopic examination further reveals that some of the individual grains at the contact are common both to the dyke and host rock, and the emplacement of the dyke is essentially non-dilational.

From these and many other observations it is concluded that the dark gneissic patches are remnants of the least granitized rock of the area derived from the original sediments and that the quartzofelspathic dyke has been formed by the metasomatic replacement of the gneiss with the introduction and fixation of potash. The marginal biotite may represent a small-scale basic front. It is also suggested that these dykes represent one of the best examples of small-scale "granitization". Further detailed work in this direction is under progress.

The author desires to express his thanks to Dr. S. Balakrishna for suggesting the problem and his valuable suggestions throughout the investigation.



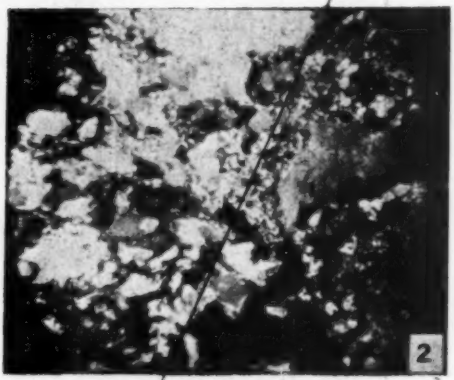


FIG. 1. GRANITE DYKE. Microcline porphyroblast with 'corroded' margins developing at the expense of the ground mass which contains quartz, biotite, and oligoclase. Clusters of myrmekite at the contact of plagioclase with Microcline. Ground mass present in the body of Microcline itself in the process of digestion.

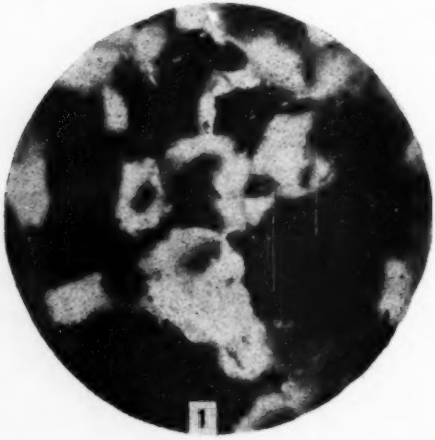
FIG. 2. HOST—ROCK—DYKE CONTACT. Gradational contact between the gneissic host and the granite dyke. The gneiss is richer in biotite and oligoclase with fine-grained quartz. In the dyke development of K felspars.

Osmania University, Y. JANARDAN RAO.
Geology Department,
February 18, 1959.

1. Janardan Rao, Y., *Curr. Sci.*, 1958, **27**, 490–91.
2. Cheng, Y. C., *Quart. Jour. Geol. Soc.*, 1944, **99**.
3. Goodspeed, G. E., *Geol. Soc. America Memoirs*, 1948, **28**, 70.
4. King, B. C., *Jour. Geology*, 1948, **56**, 474.
5. Ramberg, H., *Chicago Univ., Chicago Press J.*, 1952, 252.

MANGANIANFLUORAPATITE FROM HONNALI, SHIMOGA DISTRICT (MYSORE STATE)

CALCAREOUS manganiferous quartzites, occurring in association with limestones in the △ 2438, North-West of Honnali, Shimoga District, Latitude 14° 15′–14° 20′; Longitude 75° 35′–75° 40′) form part of the Shimoga Schist belt of the West Central group of Dharwars of Mysore. These rocks are snuff-brown in colour, due to the coating of the manganiferous and ferruginous materials, and those that are exposed on the top of the △ 2438 have developed good crystals of Pyrolusite. The freshly fractured portions of the rock reveal the typical fine-grained granulitic texture of a quartzite. During the course of microscopic investigation of these rocks, it is found that quartz and calcite contain numerous minute needles of a mineral, which is identified as manganianfluorapatite on the basis of its optical and chemical characters described in this paper.



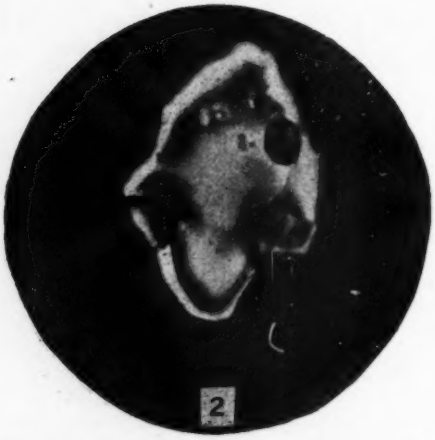


FIG. 1. Calcareous quartzice showing needle-like inclusions of Manganianfluorapatite in quartz. Crossed nicols × 23.

FIG. 2. Inclusions of Manganianfluorapatite in a grain of quartz, separated from the rock. Crossed nicols, × 90.

The microsections of the rock reveal fine-grained granulitic quartz and calcite, masked by ferruginous and manganiferous patches. Almost all the grains of quartz show numerous needle-like inclusions of the mineral manganapatite (Fig. 1) which shows straight extinction with negative elongation, and a faint pleochroism, which is as follows:—

X = Pale bluish green.

Z = Pale yellow or colourless. $X > Z$.

The refractive indices of the mineral determined by the Viola-Becke method,[1] are as follows:— $N_0 = 1{\cdot}644$; $N_E = 1{\cdot}639$; and $N_0 - N_E = 0{\cdot}005$ (calculated from indices). It is found that quartz grains, separated from the rock, show the presence of needle-like inclusions (Fig. 2). The birefringence of one such inclusion, as determined by the Berek's compensator, is 0·00507, which agrees very closely with the value obtained by calculation from indices. The optical characters of the mineral, under study, are in very close conformity with those of the manganianfluorapatite, reported by Quensel[2] (1937).

The rough chemical composition of the mineral, as read off from the variation diagram given by Winchell for the Fluor–, hydroxyl–, and chlor-apatite system,[3] is as follows:—

$Ca_5P_3O_{12}F = 49{\cdot}29\%$
$Ca_5P_3O_{12}OH = 39{\cdot}44\%$
$Ca_5P_3O_{12}Cl = 11{\cdot}27\%$

When a nitric acid extract of the powder of the quartz grains, separated from the rock, was boiled with excess of lead peroxide, the solution turned distinctly violet, indicating the presence of manganese (Volhard's test).[4] When the solution of the powder of the quartz grains, obtained by treating with hot dilute nitric acid, was filtered and when ammonium molybdate was added to the filtrate, a yellow precipitate was obtained, indicating the presence of phosphate, presumably apatite.[5] Thus the above tests have clearly established the presence of manganese and phosphate in the mineral.

The mineral has, therefore, been identified as manganianfluorapatite.

Manganapatite has been reported from Sweden by Quensel[6] (1937) and Mason[7] (1941). In

India, Fermor[8] (1909) has reported its occurrence in Kodurites of Vizagapatam District. This is the first reported occurrence of the mineral in Mysore.

M. G. CHAKRAPANI NAIDU.
V. VENKATACHALAPATHY.

Department of Geology,
Central College,
Bangalore, *February* 26, 1959.

1. Viola, *Manual of Petrographic Methods*, by Johannsen, 1918, pp. 276–77.
2. Quensel, P., *Elements of Optical Mineralogy*, by Winchell, 1951, Pt. II, p, 198.
3. Winchell, A. N., *Ibid.*, Fig. 113, p. 200.
4. Fermor, L. L., *Memoir, G.S.I.*, 1909, **37**, Pt. I, p. 225.
5. —, *Ibid.*, p. 220.
6. Quensel, P., *Geol. För., Förh.*, 1937, **59**, 257.
7. Mason, B., *Ibid.*, 1941, **63**, 279.
8. Fermor, L. L., *Memoir, G.S.I.*, 1909, **37**, 205–06; 1073–74.

THE RELATIVE IMPORTANCE OF HEREDITY AND ENVIRONMENT IN MUTTON SCORE AND FLEECE CHARACTERISTICS IN AUSTRALIAN MERINO SHEEP

ESTIMATES of heritability for fleece characteristics in Australian Merino sheep have been reported by Morley.[1,2] Similar values for mutton type have also been recorded.[3,4] However, no study has been made to estimate genetic correlations between fleece characteristics and mutton type. Further, as our present knowledge on the relative importance of heredity and environment in mutton type and fleece characteristics is lacking, this study was undertaken.

The flock of Peppin Merino sheep in which the observed animals were born has already been described[5] in detail. The measured animals comprised of 269 ewe lambs born in the autumn of 1952. These animals came from seven selection groups. The number of sires used was 47.

The conditions of management were similar to those described by Morley.[1]

Scoring for mutton type was done according to the procedure already mentioned.[6] Fleece characteristics were measured by the standard methods used[1] at Trangie Agricultural Experiment Station.

Methods of analysis of variance and co-variance as proposed by Hazel *et al.*[7] have been used. Data were analysed on sire within selection group basis. Variance between sires are probably slightly less than that in random breeding population because variance among selection groups has been removed. The relative importance of heredity and environment is measured as per the formula already described.[5]

The mean values with standard deviations for mutton score, clean fleece weight, staple length, and crimp per inch were $4 \cdot 59 \pm 2 \cdot 33$, $7 \cdot 36 \pm 0 \cdot 94$ (lb.), $9 \cdot 84 \pm 0 \cdot 87$ (cm.), and $10 \cdot 15 \pm 1 \cdot 98$, respectively.

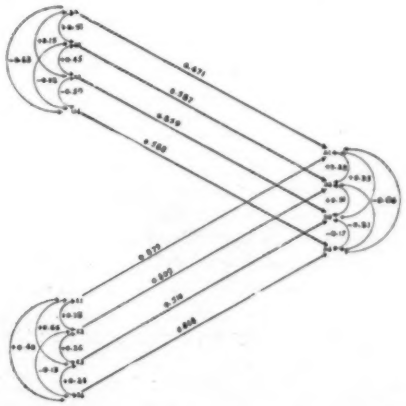


FIG. 1. Path coefficient diagram illustrating the Genetic (G), Environmental (E) and Phenotypic (X) relations between mutton score and fleece characteristics. Suffixes 1, 2, 3 and 4 represent mutton score, clean fleece weight, staple length and crimp per inch, respectively.

Figure 1 is a graphical presentation of the results obtained and sets out genetic and environmental factors causing variation in the observed phenotypic values. The path coefficients, represented by straight lines, indicate the quantitative importance of each source in causing variation. The direct influence of the cause to the effect is shown by the arrows while the relation between each source is represented by correlation coefficients. These are shown by curved double-headed arrows.

The path coefficient is defined as "the ratio of the standard deviation of the effect when all causes are constant except the one in question, the variability of which is kept unchanged, to the total standard deviation". Each path is therefore calculated by dividing the square root of the variance for a given source by the square root of the phenotypic variance. As heritability is the ratio of the additive genetic variance to the total phenotypic variance, in this case, it can be directly calculated by squaring the individual path coefficient.

The following points of interest emerge from Fig. 1 :—

(*a*) *Phenotypic correlations.*—(i) There is no significant correlation between mutton score and

crimp per inch although mutton score is positively correlated (significant) with each of staple length and clean fleece weight; (ii) clean fleece weight has a positively significant correlation with staple length although its association with crimp per inch is negatively significant; and (iii) there is a negative (significant) correlation between staple length and crimp per inch.

(*b*) *Genetic correlations.*—(i) Mutton score is positively correlated with each of clean fleece weight and staple length although it has a negative correlation with crimp per inch; (ii) clean fleece weight is positively correlated with staple length and negatively correlated with crimp per inch; and (iii) there is a negative correlation between staple length and crimp per inch.

(*c*) *Environmental correlations.*—(i) Mutton score and clean fleece weight have a positive environmental correlation; (ii) clean fleece weight and crimp per inch have significantly negative correlation; and (iii) the remaining correlations are all positively significant.

(*d*) The heritability estimates (square of path coefficients) for mutton score, clean fleece weight, staple length, and crimp per inch are 22, 34, 74 and 35%, respectively. Environment, therefore, plays greater part in causing variations in mutton score, staple length, and crimp per inch than does heredity.

Genetic and phenotypic correlations amongst the fleece characteristics confirm the earlier findings[1,2] in Australian Merino sheep. However, the association of mutton score with fleece characteristics is being reported here for the first time. Our results suggest that selection for mutton type in this breed will increase the staple length and the clean fleece weight but there will be, however, an appreciable decline in crimp per inch.

G. C. Taneja.

N.S.W. University of Technology,
Sydney (Australia), and
College of Veterinary Science and
Animal Husbandry-*cum*-Livestock
Research Institute, Mhow (M.P.),
October 10, 1958.

1. Morley, F. H. W., *N.S.W. Dept. Agric. Sci., Bull. No.* 73, 1951.
2. —, *Aust. J. Agric. Res.*, 1955, **6**, 77.
3. McMahon, P. R., *N.Z. Soc. Anim. Prod. Proceed.*, 1943.
4. Taneja, G. C., *J. Genet.*, 1958, **56**, 1.
5. —, *Aust. J. Agric. Res.*, 1955 *a*, **6**, 343.
6. —, *Ibid.*, 1955 *b*, **6**, 882.
7. Hazel, L. N., Baker, M. L. and Reinmiller, C. F., *J. Anim. Sci.*, 1943, **2**, 3.

BIOLUMINESCENCE IN VISAKHAPATNAM HARBOUR

Emission of light or bioluminescence has been independently developed in diverse groups of animals and it is interesting to note that this phenomenon is almost exclusively confined to marine organisms. Among the Protozoa the Radiolarians and Dinoflagellates are the only groups representing bioluminescent forms. Harvey[1] has given an excellent account of all luminous organisms reported up to 1952.

Except for the report of a luminescent Radiolarian *Thalassicolla* sp.[2] off the Andaman Islands, in the Bay of Bengal, and some bioluminescent animals in the Gangetic delta,[3] published information on bioluminescence in the coastal waters around India is very scanty, even though many casual reports have been made without tracing the light emission to any particular organism or group of organisms.

While making routine plankton collections after dusk in the local harbour we observed on the night of 7th November 1958, intense emission of bluish-white light when the water in the Southern Lighter Channel leading to the Turning Basin was disturbed. When the sample of plankton was kept undisturbed in a dark room in the laboratory numerous rapidly moving luminescent sparkles were observed. Microscopic examination of the sample showed that the plankton contained swarms of the dinoflagellate *Peridinium granii* Ostenfeld[4] together with a few Diatoms, Copepods and Rotifers. By isolating the Peridinians and keeping them in Whatman-42-filtered seawater it was confirmed that the luminescence was due to these organisms. The water in the Channel continued to be luminescent for the next two days and thereafter the Peridinians dwindled in numbers rapidly with a corresponding fading and final disappearance of the luminescence after about a week.

To observe whether there is a day and night rhythm in the production of light by these organisms, the plankton samples were kept in finger-bowls in a dark room and observations were made at regular 3-hour intervals after the eyes were thoroughly dark-adapted. The emission of light started at dusk and became intense towards midnight and finally faded at the approach of dawn. Similar day and night rhythms have previously been reported among other Peridinians also.

When the samples were fixed by the addition of formalin there was continuous emission of light for 15 to 20 seconds until the organisms were killed.

Attempts are being made to culture these Peridinians for further observations.

We are thankful to Sri. D. V. Subba Rao for identifying the Peridinian.

This work has been carried out with the funds provided by the Forest Research Institute obtained from various sources for the execution of the Scheme on "Protection of Timber against Marine Organisms Attack".

Department of Zoology, Andhra University, Waltair, *March* 13, 1959.

P. N. GANAPATI.
D. G. V. PRASADA RAO.
M. V. LAKSHMANA RAO.

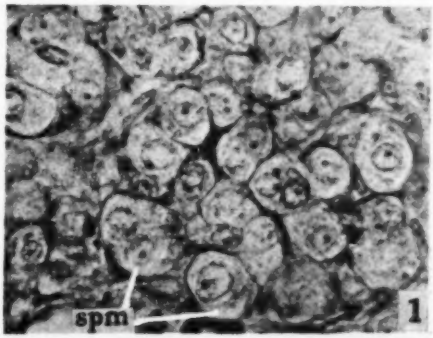
1. Harvey, E. N., *Bioluminescence*, Academic Press, New York, 1952, p. 649.
2. Alcock, A., *A Naturalist in Indian Seas*, 1902, p. 136–37.
3. Prasad, B., *J. Asiat. Soc. Bengal, N.S.*, 1923, **18**, 581–84.
4. Schiller, J., "Dinoflagellate," in Rabenhorst's *Kryptogamen-Flora Deutchlands, Osterreichs und der Schweiz*, Bd. X. Teil 2.
5. Herdman, W. A., *Founders of Oceanography and Their Work*, London, Chap. XII, 1923 pp. 212–30.

ON THE STRUCTURAL AND FUNCTIONAL DIFFERENCES BETWEEN THE ANTERIOR AND POSTERIOR TESTIS IN THE CATFISH, *MYSTUS SEENGHALA* (SYKES)

KERR[5] has stated that the sperm duct of *Polypterus* "is not, except near its termination, a simple tube but contains a network of cavities continuous with those of the testis. It is in fact not a simple duct but a portion of the testis which has become sterile". Jungerson (cited by Kerr[5]) recorded a homologous condition of the posterior testis in the young teleosts.

A detailed study of the seasonal histological changes occurring in the testis of *M. seenghala* reveals that while its anterior three-fourths is functional, the posterior one-fourth is sterile. The marked seasonal changes are restricted to the functional part only. This species breeds once a year. As in the case of many teleosts[4,7,8] the testis has a characteristic period of rest, activation, growth, maturity and depletion. The period of active spawning of *M. seenghala* is from March to May in the river Ganges at Banaras. A rise in the water temperature appears to be one of the chief factors influencing spawning as in the case of the Perch,[8] *Gasterosteus aculeatus*,[1] *Fundulus heteroclitus*,[6] *Galeichthys felis*,[2] *Lepomis macrochirus*[3] and *Huro salmoides*.[3]

Figures 1 and 2 represent the structure of the anterior and posterior testis during its resting phase. In the anterior testis the lumen of the lobule is more or less completely displaced by the spermatogonia and each lobule looks like a cord of germ cells (Fig. 1).



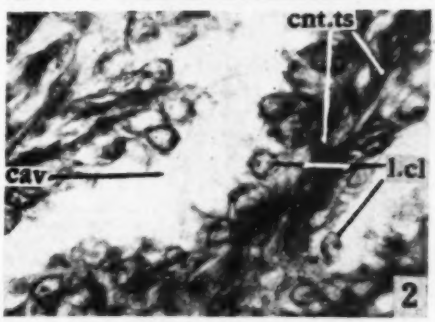


FIG. 1. Showing the structure of the anterior testis during the resting phase, × 450.

FIG. 2. Showing the structure of the posterior sterile part during the resting phase, × 700.

Bouin and Haematoxylin–Eosin.

cav.—cavity, *cnt.ts.*—connective tissue, *l.cl.*—lining cell, *spm.*—spermatogonia.

In the 'transitional zone' between the functional and sterile regions, the spermatogonia are seen towards the outer margin, which numerically dwindle and disappear in the posterior part.

The sterile part is formed of a network of cavities which is lined by small cells (Fig. 2). These cavities may represent the lobules and the lining cells, the degenerate spermatogonia. The cells do not show any seasonal variation. During the spawning phase the cavities are distended with sperms and establish connection with the sperm duct which is situated on the inner margin of the testis. Further behind, the sperm ducts on either side unite to open into the common urinogenital papilla. In the depleted testis the cavities are prominent with scattered sperms. But during the accompanying resting phase they collapse, and a quantitative

increase in the connective tissue elements lying in between is evident (Fig. 2).

Thus the structure of the posterior testis of *M. seenghala* may be interpreted as the retention of a juvenile teleostean[5] feature which is comparable to the condition prevailing in *Polypterus*.[5]

The details of the gonadial cycle are being communicated for publication elsewhere.

Department of Zoology, A. G. SATHYANESAN.
Banaras Hindu University,
Varanasi-5, *December* 5, 1958.

1. Craig-Bennett, A. *Phil. Trans. Roy. Soc. Lond.*, 1931, **219**, 197–279.
2. Frederick, J. N., *Anat. Rec.*, 1941, **81**, 27.
3. James, M. F., *J. Morph.*, 1946, **79**, 63–89.
4. Jones, J. W., *Proc. Roy. Soc. Lond.*, 1940, **128**, 499–509.
5. Kerr, G., *Text-Book of Embryology*, MacMillan & Co. Ltd., London, 1919.
6. Matthews, S. A., *Biol. Bull.*, 1939, **76**, 241–50.
7. Sathyanesan, A. G., *Indian J. Vet. Sci. Anim. Husbandry*, 1958 (in Press).
8. Turner, C. L., *J. Morph.*, 1919, **32**, 681–711.

DIFFERENTIAL RESPONSE TO POTASH APPLICATION IN THE SWEET POTATO (*IPOMOEA BATATAS*)

WITH a view to ascertaining the role of variety in the uptake of potash in the sweet potato, a preliminary trial was undertaken during 1957-58 with eight varieties and two levels of K_2O (0 and 100 lb. per acre as sulphate of potash). The results of this trial are reported here.

The varieties used in the trial were Yellow Jersey (USA), F.A. 17—White (China), White Star (USA), Batan Appu (Ceylon), Gwalior Red (M.P.), Gwalior White (M.P.), Coimbatore Local (Madras) and Rani (Mysore). They were chosen at random from the genetic stocks maintained at the Station for breeding work. They were planted on 6-11-1957 in two replications, each comprising five rows of 35 sets. The fertilizer was applied in furrows at the time of planting. The trial was harvested on 15-4-1958. The data on yield are given in Table I.

From Table I it would be clear that sweet potato varieties used in the trial gave a marked differential response to potash application. Further investigations are in progress.

It is not common that different varieties of a crop plant respond differently to a given level of a fertilizer. Ahlgren and Sprague (1940) found that varieties of white clover (*Trifolium repens*) differed in their response to mineral fertilizers. In maize (*Zea mays*) inbred lines and the F_1 hybrids frequently show differential response to various nutrients including phosphorus and nitrogen (1955). In the potato (*Solanum tuberosum*) foreign varieties like Up-to-Date, Craig's Defiance, Furore and Voran showed a higher response to potash than the local varieties, *Phulwa* and *Darjeeling Red Round* in trials, conducted at this Institute (1957).

TABLE I

Showing the effect of potash application on the yield of eight varieties of the sweet potato

Sl. No.	Variety	Mean yield per acre (calculated) in Md.		Per cent. increase in yield of K_1 over K_0 plots
	Treatments →	K_0	K_1	
1	Gwalior White ..	45·05	54·19	20·20
2	Gwalior Red ..	70·88	97·66	37·50
3	Batan Appu ..	59·86	82·86	38·40
4	Yellow Jersey ..	47·26	96·41	104·00
5	F.A. 17 White ..	53·56	127·60	138·20
6	White Star ..	36·86	90·42	145·30
7	Coimbatore Local ..	21·74	67·74	211·30
8	Rani ..	10·40	41·59	300·00

Our thanks are due to Dr. Pushkarnath, Director of the Institute, for his keen interest in the work.

K. N. CHHIBBER.
M. J. DESHMUKH.
Central Potato Research Institute,
Regional Research Station,
Patna, *May* 5, 1958.

1. Ahlgren, G. H. and Sprague, H. B., *New Jersey Agric. Exp. Sta. Bull.*, 1940, 676.
2. Hays, H. K., Immer, F. R. and Smith, D. C., *Methods of Plant Breeding*, McGraw-Hill Publishing Co. Ltd., London, 1955.
3. Anonymous, 1957, *Progress Report of the Central Potato Research Institute, Patna, for the period from August* 1949 *to March* 1956.

USE OF POLYTHENE BAGS TO SECURE HIGH INFECTION BY *TOLYPOSPORIUM PENICILLARIAE* BREF. IN *PENNISETUM TYPHOIDES* STAPF. AND HUBBARD

WHILE surveying the incidence of smut disease of bajri (*Pennisetum typhoides* Stapf. and Hubbard) in Gujarat it was observed that in Kutch the smut infection was as high as 5%, presumably, due to the practice of irrigating the bajri fields at the time of flowering and the disease was absent in Saurashtra where the practice of irrigating the bajri fields is not followed. While testing the virulence of various isolates and resistance of several varieties of

bajri against smut, at the Institute of Agriculture, Anand, it was experienced that humidity higher than 90% was essential to secure high infection by artificial inoculation.

The usual practice of covering the inoculated earheads with butter paper bags for protection against aerial infection was found unsatisfactory for production of high infection under normal field conditions with humidity 90% or below.

The butter paper bags were, therefore, replaced by polythene bags with an idea that the water of transpiration may be retained to provide enough humidity for penetration and infection by the smut fungus.

In the month of August 1958, when there was long period of drought and humidity much below 90%, the earheads in boot-stage[1] were inoculated with sporidia. Such earheads were then covered with polythene bags of 10" × 3½". At the same time several such inoculated earheads were also covered with butter paper bags (Fig. 1). Ten days after inoculation of the

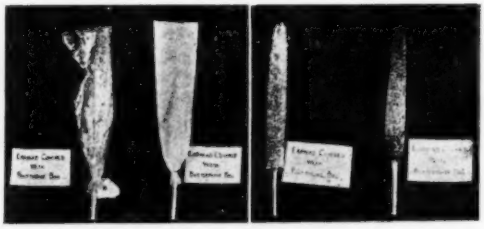


FIG. 1. Retention of water of transpiration in the form of film and drops in polythene bag.

FIG. 2. Huge number of sori in place of grains when covered with polythene bag. Sori are comparatively bigger than grains.

earheads the observations on infected earheads and number of sori present on them were obtained as recorded in Table I.

TABLE I

Type of bags used	No. of earheads covered after inoculation	No. of earheads infected	Per cent. disease	Mean no. of sori per earhead
Polythene ..	175	118	67·58	63·00
Butter paper	35	0	0·00	0·00

The results in Table I show that the infection was more than satisfactory where the earheads were covered with polythene bags whereas there was no infection on the earheads covered with butter paper bags (Fig. 2).

It seems that the water of transpiration which was accumulated in the polythene bags (Fig. 1) provided almost 100% humidity which helped in germination of sporidia, and penetration and infection by the pathogen into the host tissue. The humidity, under butter paper bags, was *at par* with field condition (about 80%) which was not suitable for infection by smut fungus. Consequently, there might have been 100% failure of infection by the pathogen.

The use of polythene bags described here for securing high infection by smut fungus in bajri is considerably superior to the butter paper bags. Furthermore, polythene bags are reusable several times.

Dept. of Plant Pathology, Institute of Agriculture, Anand, *September* 30, 1958.

M. H. PATEL.
M. V. DESAI.

1. Bhatt, R. S., " The mode of infection of the bajri plant (*Pennisetum typhoides* Stapf. and Hubbard) by the smut *Tolyposporium penicillariæ* Bref.," *J. Indian bot. Soc.*, **1946, 25,** 163-86.

SOME PARASITES OF SUGARCANE SCALE *ASPIDIOTUS* (TARGIONIA) *GLOMERATUS* GREEN

NARAYANAN and Rao[1] have recorded two parasites, namely, *Anabrolepis mayurai* (Encyrtidæ) and *Azotus delhiensis* Lal (Eulophidæ) from the sugarcane scale, *Aspidiotus glomeratus*. The author, while studying the biology of this scale insect at Sugarcane Breeding Institute, Coimbatore, encountered four different species of parasites ; three belonging to the family Encyrtidæ, *viz.*, *Xanthœncyrtus fullawayi* Timb. ; *Microterys* sp. and *Anabrolepis bifiasciata* Ishii and one to the family Euliphidæ, namely, *Azotus chionaspidis* How.

Among the four parasites mentioned above, *X. fullawayi* Timb. has been reported as a parasite of *Trionymus insularis* Ehrhorn and *Saccharicoccus sacchari*[2] from Hawaii. *Microterys* sp. and *A. chionaspidis* How. have been found mostly as parasite of different species of Coccids in several countries. These parasites were found only in small numbers and seemed to be of little consequence for the control of the scale insect. However, *A. bifiasciata* Ishii was observed to prevail on a much larger scale. In Japan, Tachikawa[3] found it as a parasite of *Ceroplastes rubens* Marshall.

An examination of the scale-infested canes at this Institute revealed that the parasitisation was as high as 10-15% during May-June and again in September-October, when several

hundreds of parasites could be collected from even a single stalk. The large-scale emergence of parasites evidently shows *A. bifiasciata* to be of a great potential utility for biological control against this sugarcane scale.

The author is thankful to Dr. N. R. Bhat, Director, Sugarcane Breeding Institute, Coimbatore, for the interest shown during the course of these studies. Grateful thanks are also due to the Head of Insect Identification and Parasite Introduction Section of the United States Department of Agriculture, for kindly identifying the insects.

R. A. AGARWAL.

Sugarcane Breeding Institute,
Coimbatore-3, *December* 22, 1958.

1. Narayanan, E. S. and Rao, Subba, B. R. *Ind. Jour. Ent.*, 1957, **19** (2), 144-46.
2. Box, H. E., *List of Sugarcane Insects*, 1953, p. 78.
3. Tachikawa, T., *Memoir of the Ehime University, Sec. VI, Agri.*, 1955, **1** (2), 9.

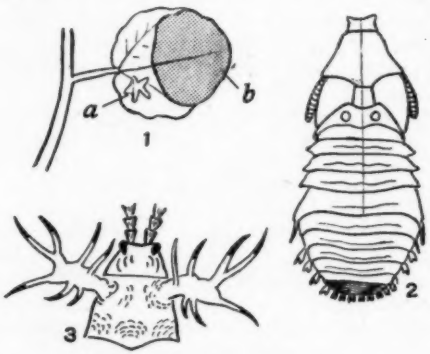
ON THE OCCURRENCE OF *HISPA PALLESCENS* GUERIN.

THE larvæ of *Hispa pallescens* were found forming blotch mines on the leaves of *Triumpheta rotundifolia* and *Abutilon* sp. during November 1956 at Dhadesugur. This appears to be the first record of this somewhat rare insect species in Mysore State.

The Mines.—The newly hatched grubs form small asteronomes (star-shaped mines). They come out of the primary mine after 48 to 60 hours and produce fresh, full depth, roundish, secondary blotch mines with wavy margins. Black frass in a mass is deposited irregularly, mainly at the centre of the mine. The mines on *Abutilon* sp. are characteristically milky to opaque white, whereas they are deep brown, almost entirely covering the leaflamina on *Triumpheta*. In the former host the grubs eat the whole mesophyll between the two epidermal layers and the mines therefore appear transparent when held against light. Part of the spongy paranchyma along with the lower epidermal layers are left intact on *Triumpheta*, which renders the mine hardly visible on the lower surface of leaves. The blotches are 2 to 2·8 cm. in diameter and only one larva feeds in each mine. Fresh linear mines are formed before pupation so that the full grown larvæ are just accommodated inside for pupation. It was observed that the full grown larva produces about 6 mm. length of mines in 2 to 2½ hours.

STAGE AND LIFE-HISTORY

Egg.—White, flattish oval, inserted singly inside the leaf tissue; incubation period 3 to 4 days.



Hispa pallescens Guerin.

FIG. 1 *a*. Primary Mine, *b*. Secondary Mine on *Triumpheta rotundifolia*.
FIG. 2. Pupa. FIG. 3. Head and Prothorax showing Spines

Larva.—Milky white, with prominent, brown mandibles; head square and retracted in the broad prothorax which is brown and strongly chitinised; antennæ three-segmented, minutely hairy; abdominal segments broadening till 5th A, bear thin pointed spinules; 5th A the broadest bears brown, robust spines protruding at sides; lateral pads on 6th to 10th A are soft, broad and serrated; anal segment is thinly chitinised with two spinules. All the abdomenal segments have transverse depressions on dorsal surface. Full grown larvæ measure 5 mm. long and 2·25 mm. broad at 5th A. The larval period is 10 to 12 days.

Pupa.—Pupa is active, mobile; light brown turning deep brown before emergence of adult. Prothorax is very large, four times the size of the head; broader (1·20 mm.) than long (0·83 mm.). Posterior end has a dorsal transverse depression. Metathorax has two black protruding knobs. 5th A, the broadest, has long out-growing spines on lateral sides; 6th A to 10th A are rounded up with semicircular posterior end. A 6, 7 and 8 possess twin spinules. 9th and 10th A fused, bearing two large pads having five serrations each. Pupal period lasts for six to eight days. The pupa falls out of the mine before emergence of the adult beetle, through posterior end.

Adult.—Rather sluggish, hardly moves if disturbed. At rest, legs are folded in, antennæ held together straight ahead setting close to the leaf. The beetles scrape the green chloro-

phyll, in short irregular arcs, copulating couples being seen from August to September. In captivity they live without food up to seven days. In nature the adults are mostly found hiding on the undersurfaces of the lower leaves. The general activity of the insect species was not observed from February to June, being hot months. The adult has been described by G. Maulik.[1]

The adult is 3·9 to 4·1 mm. long and 2 mm. broad. Out of the 6 species belonging to the genus *Hispa* (by Maulik[1]) *Hispa pallescens* only is brown in colour, all the remaining being black.

I am greatly indebted to Dr. Hall, of Commonwealth Institute of Entomology, London, for the identification of the insect species.

Dhadesugur, S. N. KADAPA.
October 24, 1958.

1. Maulik, *Fauna of British India, Chrysomellidæ, Hispinæ and Cassidinæ*. **4**, 254.

OCCURRENCE OF STERILITY IN *PHASEOLUS MUNGO* (*UDID*)

Phaseolus mungo, popularly known as *Udid*, belongs to subfamily Papilionatæ under natural order Leguminosæ. *Udid* flower is a typical Papilionaceous flower having standard petal, overlapping the wing and keel petals, andrœcium and gynæcium. Normally anthers dehisce, prior to opening of flowers. At the time of anthesis

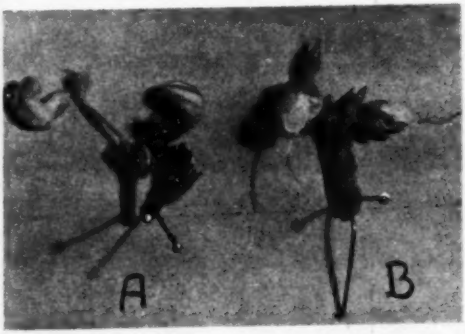


FIG. 1. (*A*) Normal flowers, (*B*) Sterile flowers.

anther-sacs are quite close to the stigma and the structure enclosed by keel petal. This mechanism secures self-pollination.

During the course of observation in the breeding material of *Udid*, at the Agricultural Research Station, Jalgaon (East Khandesh), the authors observed some sterile plants in the variety *Idgaon* 2-3. In appearance, the plants were alike but in sterile plants, pod-setting did not occur. On closer observation the flowers showed some deviation from the natural ones. The style was found elongated and protruding beyond the corolla. This elongation of style was noticed prior to opening of flowers and even earlier than anthesis (Fig. 1 B). Stamens were of normal size. Pollen grains showed normal appearance to iodine staining.

The sterility therefore is due to hercogamous condition, preventing self-pollination. Natural cross-pollination is normally negligible in *Phaseolus mungo*. These conditions account for lack of pod-setting in these plants.

This appears to be the first report of sterility in *Udid*. Further work regarding maintaining sterility by sib-mating and crossing it with desirable types of *Udid* for study of mode of inheritance of this character is in progress.

Agricultural Research Station, M. M. GHARE.
Jalgaon (East Khandesh), J. S. THAKARE.
November 12, 1958. P. D. PATIL.

SYSTEMIC ACTION OF CERTAIN ORGANOPHOSPHOROUS INSECTICIDES

STUDIES for systemic action were pursued under pot culture conditions by the author with reference to *Parathion*–(Diethyl-paranitrophenyl-thiophosphate), *Systox* (Diethoxythiophosphoric ester of 2 ethyl mercapto ethanol) and *Pestox*-3H-(Bisdimethyl amino phosphorus anhydride). The results obtained are presented in this note.

Six weeks old healthy cowpea plants were treated with the above-mentioned formulations. In one set of trials, the spray fluid was applied to the soil at the base of the plants, while in the other the same was used as a direct foliar spray at 0·15% concentration. The next day after treatment, twenty wingless adults of the aphid-*Aphis medicagenis* K. of uniform age drawn from the aphid culture maintained in the laboratory were introduced over each of the treated plants and covered over with a wire gauze cage. Colonisation of a similar number of aphids was continued for a fortnight. Counts of the surviving population were recorded everyday at 9 a.m. over a period of 30 days. The experiments were replicated four times, maintaining an untreated check for comparison.

Due to the intake of the poisoned sap, a characteristic restlessness was observed in the behaviour of the aphids, introduced on the plants treated with Pestox and Systox at 0·15% concentration, either as a soil application or as a direct foliar spray. These wandered from

place to place on the plant and ultimately dropped down dead in about twelve hours. The percentage of mortality was cent per cent. in the course of twenty-four hours under both the formulations. The toxicity of the plant was maintained for the first ten days following the insecticidal treatment. Subsequent to this the introduced aphids were able to thrive and gradually the percentage of mortality declined. No such results were noted in the case of plants treated with Parathion, and the colonised aphids began to establish themselves as in the control. It is, therefore, evident that Parathion is not absorbed in sufficient quantities to render the sap toxic. The present study also confirms that the active principle of Systox and Pestox 3H gains an entry into the cell sap, both through the medium of the root system as well as by contact with the aerial parts of the plant.

A detailed account of the above investigations will be published elsewhere.

Entomological Division, K. R. NAGARAJA RAO.
Agricultural Research Institute,
Coimbatore-3, *December* 12, 1958.

TWO NEW SPECIES OF *DISCOSIA* FROM BOMBAY

THE fungus genus *Discosia* is represented by only two species in India, *viz.*, *Discosia himalayensis* Died. and *Discosia tenzingii* Lacy. (1946, 1958). Saccardo (1931) records 19 species of this genus. Besides the fungus genus has not been previously reported from Bombay State. The species were, therefore, studied in detail and are presented here as new to science with Latin diagnosis on the basis of comparative morphology and host relationship.

1. *Discosia hiptages* TILAK sp. nov.

Pycnidia nigra, dispersa, amphigena, discoidea, immersa in textus plantæ hospitis, magnit. 119-89 ⇌ 102-56 μ. Conidiophori bulbosi, breves. Conidia hyalina, 2-3 septatæ, cylindrica, fastigata ad utrumque apicem, tenuiter curvata, 25-34 ⇌ 2-3·5 μ, una appendice ad utrumque apicem ornata. Lectus in foliis viventibus *Hiptages bengalensis* Kurz. mensibus julio et augusto ad Poona in India anni 1958 a S. T. Tilak.

2. *Discosia bombycina* VISWANATHAN sp. nov.

Pycnidia fusce brunnea, amphigena, dispersa, globularia, immersa in textus plantæ hospitis, 118-202 μ diam., ostiolate, ostiolo magnit. 30-50 μ. Conidiophori bulbosi, breves. Conidia hyalina, vulgo 4-cellulata, cylindrica, tenuiter curvata, magnit. 31-40 ⇌ 2·5-4 μ, ornata una appendice filiformi, hyaline, ad utrumque apicem magnit. 3·5-7·8 μ.

Typus lectus in foliis viventibus *Syzygii cumini* Skeel ad Poona in India die 15 Julii anni 1958 a T. S. Viswanathan.

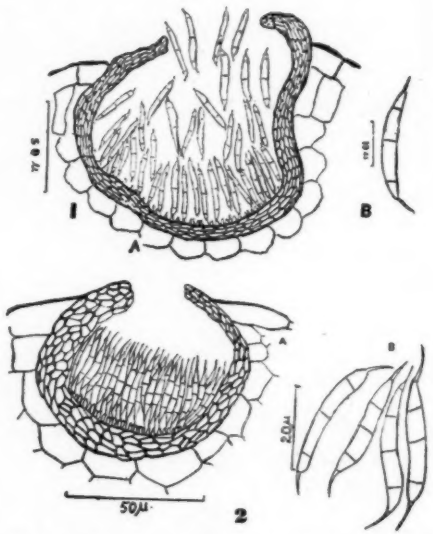


FIG. 1. *Discosia hiptages.* (A) Section through pycnidium, (B) Conidium.

FIG. 2. *Discosia bombycina.* (A) Section through pycnidium, (B) Conidia.

It may be noted that while the two previously described Indian species of *Discosia* were collected at very high altitudes, the present collections were made at comparatively low altitudes of about 1800 ft. The genus is also a new record for Bombay fungi.

The type specimens have been deposited in Herbarium Cryptogamæ Indiæ Orientalia, New Delhi, India and Herbarium of the Commonwealth Mycological Institute, Kew, England.

The authors are very grateful to Prof. M. N. Kamat for guidance, to Dr. S. P. Agharkar, Director, for laboratory facilities and to Rev. Father H. Santapau for Latin diagnosis.

M.A.C.S. Laboratory, S. T. TILAK.
Law College Buildings, T. S. VISWANATHAN.
Poona-4,
December 31, 1958.

1. Lacy, R. C., *Discosia tenzingii*—A New Species from Darjeeling, *Ind. Phytopath.*, 1958, **2**, 82-84.
2. Saccardo, P. A., *Sylloge Fungorum*, 1931, **25**, 517.

MEIOTIC STUDIES IN *CROTALARIA SERICEA* RETZ. AND THE BASIC NUMBER IN THE GENUS *CROTALARIA*

CYTOLOGICAL investigation in the genus *Crotalaria* was started in India by Ramanujam *et al.*[1] in 1933. They determined the chromosome number in some four species of this genus and found $n = 8$. Later workers have reported $2n = 16$ or 32,[2] except in one species *Crotalaria incana* in which somatic number has been reported to be 14.[3] Dutta (1933),[4] however, reported 10 as the haploid number in the genus *Crotalaria*. There is thus no unanimity about the basic chromosome number in this genus although the majority of the workers reported it to be 8.

Instead of investigating the cultivated or the previously studied species of the genus it was planned to study wild species growing in nature in different localities. *Crotalaria sericea* is one such species which is found growing wild at different places near about Patna and investigation in this species has, therefore, been made. For the sake of cytological studies anthers were squashed to study meiosis in the PMCs. Aceto-carmine squash gave quite satisfactory preparation. In anthers, the division in the PMCs was not synchronous. Quite a high percentage of cells showed normal metaphase and anaphase but about 5% of PMCs displayed some meiotic irregularities. In most of the nuclei studied at diakinesis, one bivalent, unlike others, took the shape of a ring. This ring-like bivalent appeared to be quite characteristic. At late mataphase seven of the bivalents separate normally (Fig. 1) and reach the two poles but one of the bivalents remains as a laggard for quite a long time. At late first anaphase when the seven chromosomes at the poles are about to enter telophase the lagging bivalent separates and the two complements pass towards the two poles but remain far behind the pole and are presumably excluded (Fig. 2) or both may be included in one telophase nucleus. This lagging bivalent was found in quite a number of PMCs and in every case they showed the above-mentioned behaviour. It is evident from the above description that in the population of *Crotalaria sericea* Retz. in which the gametic number was determined as 8[5] there are PMCs with regular meiotic divisions giving rise to normal gametes with 8 chromosomes and also PMCs in which irregular behaviour of a bivalent may give rise to gametes with 7 or 9 chromosome numbers. The question about the basic chromosome number can therefore be finally decided when a large number of plants in the genus are cytologically investigated. Studies in this direction are being continued.

Department of Botany, R. P. ROY.
Patna University, R. P. SINHA.
Patna, *November* 25, 1958.

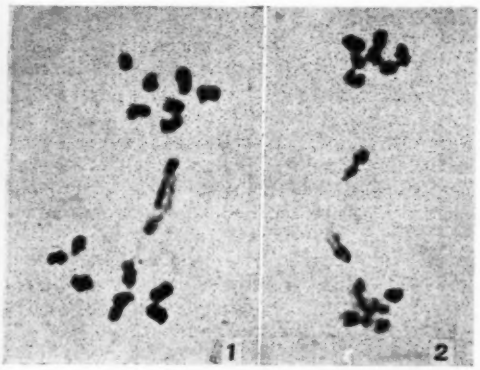


FIG. 1. Photomicrograph of a pollen mother cell of *Crotalaria sericea* Retz. showing early anaphase in which a ring bivalent is still at the equator, × 1,500.

FIG. 2. Photomicrograph of a pollen mother cell of the same species showing late anaphase in which the complements of the lagging bivalent have separated but have a tendency to be either excluded from the telophase nuclei or both to be included in only one nucleus.

1. Ramanujam, S. *et al.*, *Proc. Ind. Sci. Congr., Agr. Sec.*, 1933, **13**.
2. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, London, 1955.
3. Atchinson, E., *J. Elisha Mitchell, Sci. Soc.*, 1950, **66**, 70.
4. Dutta, R. M., *Curr. Sci.*, 1933, **2**, 69.
5. Rao, Y. S., *Ind. J. Genet. and Pl. Breeding*, 1943, **3**, 64.

PRELIMINARY REPORT OF THE FOSSIL LEAF-IMPRESSIONS FROM MEWAR STATE

IN 1955 Murty reported the occurrence in Mewar State of a Tertiary limestone containing gastropods and "abundant Dicot—and Monocot —leaf-impressions". There are two localities of this limestone "one at the tenth milestone on the Udaipur-Gogunda Road and the second about six furlongs west-north-west of the first occurrence". From the second locality Dr. Mrs. Chitaley collected a few specimens of the leaf-impressions in December 1956 while on an excursion with the students.

The specimens are incomplete impressions of leaves showing good details of venation. There

are six of them which have been selected for detailed examination. For the present they have been numbered as A, B, C, D, E and F. Of these A and B seem to be similar. So far it has not been possible to identify the specimens with the modern plants and their investigation is in progress. However, four of them are figured here to show their general structure and venation. In all the specimens the leaves are simple and dicotyledonous showing unicostate, reticulate venation.

The author is grateful to Dr. Mrs. S. Chitaley for giving the necessary guidance in this work.

Botany Department, MRS. T. TRIVEDI.
College of Science,
Nagpur, *December* 3, 1958.

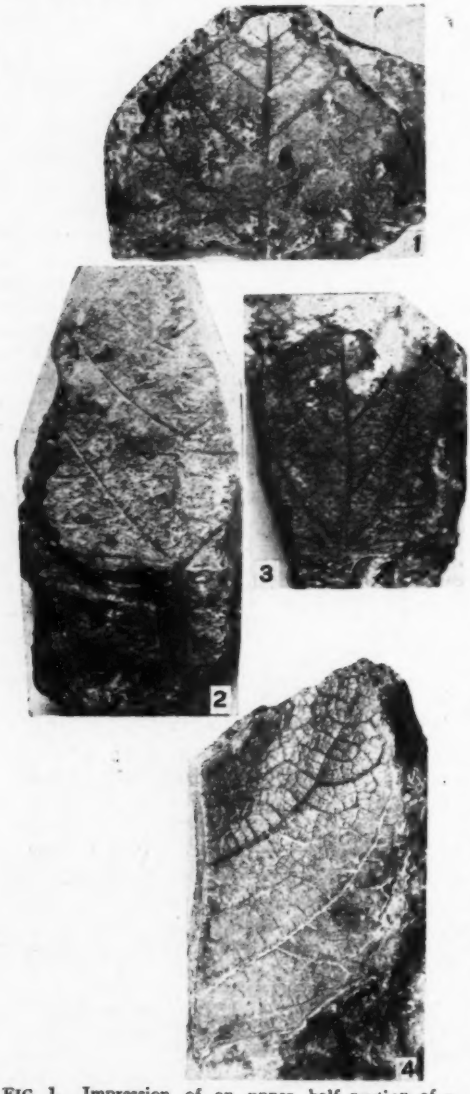


FIG. 1. Impression of an upper half portion of a Dicotyledonous leaf (A) showing crenate margin.
FIG. 2. A fossil Dicotyledonous leaf (F) with petiole.
FIG. 3. Almost a complete impression of a small leaf. (E).
FIG. 4. Impression of a fragment of a large leaf (D) showing distinctly the curved midrib, lateral veins, and reticulum.

1. Murty, T. V. V. G. R. K., *Proc. Indian Sci. Cong. Assoc.*, Pt. 3 (Abstracts), 1955, p. 181.

CONTROL OF MANGO MALFORMATION DISEASE

A DISEASE affecting the mango inflorescence, turning it into malformed leafy witches brooms, was reported from Poona by the author.[1] The diseased panicles were found to be parasitised within the tissue by a species of *Eriophyes*. These microscopic mites are both inter- and intra-cellular, inciting cell enlargement and rapid multiplication of undifferentiated type of tissue. The mites can be located in any part of the meristematic tissue of the malformed spikes during the flowering season. After the drying up of the diseased panicles, the mites can be located within the tissues of the axillary buds of shoots from which new inflorescences are formed in the succeeding year.

Observations carried out during the last four years to evaluate the role of the mites in the incitement of the disease have given very interesting data. Fifty infected trees which were fairly well separated in distance were marked, and the counts were made for the number of infected inflorescences. In 20 trees which on an average had 28 to 30 malformed inflorescences, the diseased shoots were excised up to one to two feet behind the inflorescence. All these were carefully collected and burnt. The other 30 trees, where the diseased shoots remained as such, served as controls.

Observations have indicated that in the trees where the diseased shoots were excised, there was reduction in the number of diseased inflorescence in the very next year, the average being 8 to 10 per tree. The systematic removal of the diseased inflorescence, for four consecutive years, has resulted in 15 of the trees being completely free from infection and the other 5 showing only one or two malformed

spikelets. In the controls, the percentage of infection remained same or increased according to the number of flowering shoots borne. In some trees all the shoots were diseased. In some instances healthy inflorescences were produced in shoots which had malformed spikelets in the previous season. The systematic eradication of infected shoots having resulted in the disappearance of the disease it has become apparent that the disease is incited by the mites. The concept of virus as being the causal agent of mango inflorescence malformation is negatived.

Pimpri, Poona, *May* 21, 1959. M. J. NARASIMHAN.

1. Narasimhan, M. J., *Curr. Sci.*, 1954, **23**, 297–99.

ON THE OCCURRENCE OF *NOSTOCHOPSIS LOBATUS* IN ASSAM

Nostochopsis was described with the type species *N. lobatus* by Wood[1] in 1869. Two other species have also been described, *N. hansgirgii* by Schmidle (1900) and *N. radians* by Bharadwaja (1934). From India *N. lobatus* was collected by Prof. Iyengar from near topslips in the Annamalais and from a stream in Tirumoorthy hills near Coimbatore. Desikachary[2] has studied these materials in detail. *N. hansgirgii* had been recorded as growing on rocks in a rivulet near Goregaon, Bombay, by Dixit (1936). *N. radians* was collected from Jog Falls, Mysore, by Bharadwaja[3] and by Prof. Iyengar, so also by Venkataraman from Tenmalai, Kerala (Personal communication). Thus, so far, the species of *Nostochopsis* seem to have been described from south of India only. The alga of present record was collected from Basishtasramam (7 miles from Gauhati town), Assam. The alga was growing on rocks in a stream of the locality and was collected more than once during the months of December-February.

The species agree to the type description of *N. lobatus*, in having a hollow thallus, filaments entangled with true branching, filaments 3·8 μ in breadth at the region of branching, intercalary (rare) and lateral (pedicillate and sessile) heterocysts. The occurrence of the alga is reported as it is a new record from the North-Eastern parts of India.

Thanks are due to Prof. H. K. Baruah, for his kind encouragement, to Mr. S. N. Barua for the fresh material recently collected by him and to Mr. G. S. Venkataraman for helping with some literature.

Botany Department, Gauhati University, Assam, *March* 4, 1959. P. R. MAHADEVAN.

1. Geitler, *Cynophyceæ in Rabenhorst's Kryptogamenflora*, 1932, **14**, 475–76, Figs. 285 & 286.
2. Desikachary, T. V., *I. B. S. Iyengar Commemoration Volume*, 1946, 225–38.
3. Bharadwaja, Y., *New. Phyt.*, 1934, **33** (1), 1–7.

MERMIS SP. (MERMITHIDAE, ASCAROIDEA, NEMATODA) AND ITS INSECT HOSTS

MANY kinds of insects are parasitised[1–7] by nematodes, particularly of the family Mermithidæ, which are of considerable economic importance.

Our breeding records show that the following species of insects have been parasitised in nature by *Mermis* sp. (probably *indica*) in Dehra Dun (unless otherwise indicated).

These data indicate that these worms have a very wide range of hosts. Their attack is mainly confined to the larvæ of Lepidoptera and rarely the larvæ of leaf-eating beetles, *e.g.*, *Calopepla leayana* Latr. (Coleoptera) and the adult grasshoppers (Orthoptera), are infested. All these nematodes were in an immature stage and belong to *Mermis* sp. (probably *indica*). The parasite worm comes out forcing its way through the body-wall between the segments. About half an hour or more is often required for complete emergence. In some cases, the worm, when about half way out from the host, coils round itself in such a form that its extrication becomes easy. The host either dies immediately at the time of emergence or leads a lingering existence for a short time.

These mermithids are usually long, slender worms which feed by the absorption of the body fluid and complete only part of their larval development in the body cavity of the host. Only one worm was found in each host, except in two insects, *viz.*, a larva of *Epiplema* sp. defoliating *Gmelina arborea* and a pyralid larva feeding on *Stereospermum* sp., harbouring two and three worms respectively. Exact larval period is not known, but in one case the worm came out from the host after 17 days. Further development of the premature, free-living worm is unknown. Two freshly emerged worms were kept on 10th July 1936 (Expt. No. 651A) in a pot having damp soil. They remained alive for 68 days. The soil was kept moist by sprinkling water when necessary.

TABLE I

Host insect parasitised		Food plant of host	Season
		ORDFR : LEPIDOPTERA	
Epiplemidæ			
Epiplema sp.	..	*Gmelina arborea*	September
Eucosmidæ			
Argyroploce cellifera Meyr.	..	*Eugenia jambolana*	do.
Geometridæ			
Hypsoidra successaria Wlk.	..	*do.*	August
Unidentified Geometrid	..	*Litsæa polyantha*	September
Hyblæidæ			
Hyblæa puera Cram.	..	*Tectona grandis*	August, September and October
Noctuidæ			
Anomis fulvida Guen.	..	*Kydia calycina*	August
Brithys crini Fabr.	..	Lily	January
Eutelia favillatrix Wlk.	..	*Lannea grandis*	October
Notodontidæ			
Neopheosia excurvata Hamps.	..	*Anogeissus latifolia*	July ; in Sillari, Nagpur-Wardha, M.P.
Pieridæ			
Pieris brassicæ Linn.	..	..	December
Psychidæ	..	*Shorea robusta*	October
Pyralidæ			
Hapalia machæralis Wlk.	..	*Tectona grandis*	July and September (Also in Rohatgaon, Hoshangabad, M.P.)
Hyptipyla robusta Moore.	..	*Cedrela toona*	July and October; in Top Slip, Nilambur (Madras)
Lamida nubilalis Hmps.	..	*Garuga pinnata*	October
Margaronia hilaralis Wlk.	..	*Anthocephalus cadamba*	September
M. pyloalis Wlk.	..	*Morus alba*	July to October
Sylepta ?alteata Fabr.	..	*Bursera serrata*	August
Tyspanodes linealis Moore	..	*Salmalia malabarica*	September
Unidentified pyralids	..	*Mallotus phillippinensis*	August
		Shorea robusta	July
		Stereospermum sp.	September
Sphingidæ			
Deilephila nerii Linn.	..	*Tabernæmontana coronaria*	November
		ORDER : COLEOPTERA	
Chrysomelidæ			
Calopepla leayana Latr.	..	*Gmelina arborea*	August
		ORDER : ORTHOPTERA	
Acrididæ			
Unidentified grasshopper	..	*Prunus persica*	September

These emergence records indicate that rainy season and winter are the normal time for the emergence of these worms. The parasite moves about slowly if the soil is wet. On a dry soil, it coils itself into a compact roll and drying is fatal. The length of these worms varies, extending from 5 to 24 cm.

Forest Research Institute, Dehra Dun, *November* 21, 1958. R. N. MATHUR.

1. Baylis, H. A., *Fauna of British India*, Nematoda, 1936, **1**, 222–25.
2. Bindra, O. S. and Kittur, S. U., *Indian J. Ent.*, 1956, **18** (4), 462–63.
3. Khan, M. Q., Murthy, D. V. and Nomani, M. Z. A., *Ibid.*, 1956, **18** (3), 299–300.
4. Krishna Ayyar, P. N., *Ibid.*, 1940, **2** (1), 96–97.
5. Mathur, R. N., *Indian For. Rec.* 1934, **20** (3), 25.
6. Mukerji, D. and Raychoudhuri, S., *Curr. Sci.*, 1956, **25** (2), 60–61.
7. Usman, S., *Indian J. Ent.*, 1956, **18** (4), 467–68.

STURMIA (S. STR.) *FLAVOHALTERATA* BISCH. (TACHINIDAE: DIPTERA) ON *PRECIS ORITHYA* SWINH. FEEDING ON *STRIGA* SP.

EARLY in 1949, the writer and his co-workers[1] had recorded the occurrence of *Precis orithya* Swinh. (Lepidoptera : Nymphalidæ) on *Striga*—the phanerogamic root parasite of Sugarcane (*Saccharum officinarum*) and Jowar (*Sorghum vulgare*) crops in the Nizamasagar area of (former) Hyderabad State. Since then observations have been continued by the writer on the evaluation of the efficacy of this insect in the biological control of *Striga*. *P. orithya* occurs also in many other parts of India and in 1953, Agarwala and Naquvi[2] made observations on its biology and carried out feeding tests in Bihar State and recorded the occur-

rence of an unidentified tachinid parasite on this insect.

During the course of investigations in Hyderabad State, one of the limiting factors observed in the natural multiplication of this insect, was the occurrence of the tachinid parasite *Sturmia* (s. str.) *flavohalterata* Bisch. The occurrence of this parasite is a new record for India, its former host records being *Amphicallia bellatrix* and *A. thelwalli* (Lepidoptera : Arctiidæ) feeding on Mlanja Cedar in Nyasaland.[3]

Seasonal history studies were carried out by periodical collections of caterpillars from a wide area and rearing them in the laboratory. The following table gives the percentage of incidence of *S. flavohalterata* during October, November and December, 1954 and 1955.

TABLE I

Locality	Percentage of incidence					
	1954			1955		
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
1 Rudroor and Akbarnagar	4·5	15·0	30·5	12·0	8·5	..
2 Varni ..	2·5	20·0	52·5	..	15·0	20·5
3 Bodhan ..	..	2·5	10·5	5·0	12·5	12·5

The larval stages of the fly are as usual entirely endoparasitic and only one maggot is found in each affected host larva ; mostly early to middle instar caterpillars are found attacked. The full grown maggot makes an incision in the ventral area of the host abdomen and emerges ; pupation is outside the body of the host probably in the soil. The pupal period ranges from 4-6 days. The adult flies, when fed with dilute honey in the laboratory, live 3-5 days.

The writer's thanks are due to the authorities of the Commonwealth Institute of Entomology, London, for the identification of the parasite. The study reported herein was carried out under the guidance of Dr. M. Q. Khan, Entomologist to the Hyderabad State Government, to whom the writer is indebted for facilities provided and encouragement given.

Entomological Section, D. V. MURTHY.*
Department of Agriculture,
Hyderabad (Dn.), *January* 7, 1959.

* Present Address: Section of Entomology, Department of Agriculture, Bangalore.

1. Murthy, D. V. and Rao, A. S., *Curr. Sci.*, 1949, **18** (9), 342.
2. Agarwala, S. B. D. and Haider Naquvi, S. Z., *Proc. Bihar Acad. Agr. Sci.*, 1953, **2**, 121-25.
3. Smee, C., "Report of the Entomological Division," *Ann. Rep. Dept. Agric. Nyasaland*, 1930, *RAE.*, **18 A**, 422-24.

COMPARATIVE EFFECTS OF POTASSIUM AND COBALT IN AN EARLY VARIETY OF RICE

IT is well known that potassium[1,4] and cobalt[2,3] play significant roles in the growth and metabolism of plants. The effects of potassium and cobalt in an early variety of rice are reported in this note.

Graded seeds of an early variety of rice, N. 136, were soaked separately in the concentrations of 1, 10, 100 and 1,000 p.p.m. of potassium chloride and cobalt chloride. After 48 hours of soaking, the seeds were washed thoroughly in water and sown in earthenware pots. The plants were then separated into two different series ; Series I was left after the initial soaking without any further treatment, while Series II was given in addition a regular foliar spray once a week with the corresponding solution in which the seeds were initially soaked. The spraying was commenced with 3-weeks old seedlings and was continued until panicle emergence. A third set of seeds soaked in distilled water served as controls.

The average days taken from sowing to ear emergence under different treatments are presented in Table I.

TABLE I

Effect of potassium chloride and cobalt chloride on time from sowing to ear emergence in the main shoot (Average of 16 plants)

Sowing date : January 17, 1958

Treatments		Days from sowing to ear emergence			
		Seed soaking (Series I)	Seed soaking *plus* spray (Series II)	Mean per treatment	Earliness (+) or delay (−) in days from control
KCl	1 p.p.m. ..	70·25	70·75	70·50	+1·28
	10 p.p.m. ..	69·56	69·81	69·68	+2·10
	100 p.p.m. ..	68·06	67·87	67·96	+3·82
	1,000 p.p.m. ..	65·31	68·06	66·68	+5·10
	Control ..	71·50	72·06	71·78	..
$CoCl_2$	1 p.p.m. ..	73·19	74·31	73·75	−0·50
	10 p.p.m. ..	74·69	75·06	74·88	−1·63
	100 p.p.m. ..	74·94	75·56	75·25	−2·00
	1,000 p.p.m. ..	75·50	75·87	75·69	−2·44
	Control ..	73·06	73·44	73·25	..

In KCl series, S.E. Mean for chemical effect = 0·21 and C.D. at 5% = 0·61.
In $CoCl_2$ series, S.E. Mean for chemical effect = 0·30 and C.D at 5% = 0·86.

A study of Table I shows that potassium chloride induced an earlier ear emergence in the treated plants. The earliness gradually

TABLE II

Effect of potassium chloride and cobalt chloride on the production of tillers and leaves and on plant height (Average of 16 plants in each series)

Treatments	No. of tillers per plant				No. of green leaves per plant				Height per plant in cm.			
	Potassium		Cobalt		Potassium		Cobalt		Potassium		Cobalt	
		As % of control		As % of control		As % of control		As % of control		As % of control		As % of control
1 p.p.m. ..	5·64	109·30	5·38	92·28	24·64	110·25	20·55	93·07	49·86	104·90	50·07	89·97
10 p.p.m. ..	5·84	113·18	5·09	87·31	25·94	116·06	19·72	89·31	51·18	107·68	48·11	86·45
100 p.p.m. ..	6·41	124·22	4·72	80·96	27·97	125·15	18·39	83·29	53·27	112·08	47·13	84·69
1000 p.p.m. ..	7·92	153·49	4·46	76·50	34·12	152·66	17·31	78·39	55·05	115·82	45·24	81·29
Control ..	5·16	100·00	5·83	100·00	22·35	100·00	22·08	100·00	47·53	100·00	55·65	100·00

increased from 1 day with the lowest concentration of 1 p.p.m. up to 5 days in the highest concentration of 1,000 p.p.m. Cobalt chloride, on the other hand, brought about a delay in ear emergence, significant results being obtained in the higher concentrations of 100 and 1,000 p.p.m.

Observations on morphological characters such as number of tillers, total number of green leaves, and height of the plants as influenced by the various concentrations of the two inorganic solutions were made several times during the life-cycle and the mean values of all the observations of both the series considered together are presented in Table II.

The results in Table II show that potassium chloride in general brought about a better vegetative growth whereas cobalt chloride brought about a depression in these aspects.

Our thanks are due to Sri. M. P. Jha, Statistician, Central Rice Research Institute, Cuttack, for help in statistical analysis.

Department of Botany, Ravenshaw College, Cuttack-3, G. MISRA. D. MISHRA.

November 24, 1958.

1. Aiyar, S. P., *Proc. Indian Acad. Sci.*, 1948, **28 B**, 202.
2. Galston, A. W. and Siegel, S. M., *Sci.*, 1954, **120**, 1070
3. Salisbury, F. B., *Plant Physiol.*, 1957, **32**, 600.
4. Sircar, S. M. and Datta, S. C., *Ind. J. Agr. Sci.*, 1957, **27**, 1.

GERMINATION OF POLLEN GRAINS OF *VITIS VINIFERA*

FOR hybridizing grapes (*Vitis vinifera* L.) successfully under Saharanpur conditions, it was considered desirable to find out a suitable culture media for testing the germinability of its pollen grains. Ziegler and Branscheidt[1] obtained maximum pollen germination with European grapes in 2½% sucrose solution at 29° C., whereas Gollmick[2] used a mixture of 5% sucrose and 2% agar in a moist chamber at 26° C.

In the present study, fresh pollen grains were collected from two high pollen yielding varieties—Large white and Black cornichon of *Vitis vinifera* L. during March 1958. They were planted in cavity slides containing varying concentrations of sucrose solution and distilled water. These slides were kept in moist petri dishes at room temperature and were examined every ten minutes under the microscope. The maximum length of the pollen tube was measured with the help of standardized occular micrometer and data are summarized in Table I.

TABLE I

Sl. No.	Media used	Pollen grain	
		% germination	Maximum tubelength (in μ) in 6 hours
1	Distilled water ..	5·7	16·2
2	2% Sucrose solution ..	7·5	29·4
3	5% ,, ..	10·2	61·8
4	8% ,, ..	12·6	114·8
5	11% ,, ..	15·3	132·5
6	15% ,, ..	36·8	162·0
7	20% ,, ..	56·6	390·3
8	25% ,, ..	70·4	491·9
9	30% ,, ..	45·1	58·9
10	35% ,, ..	40·2	14·7

It is seen from Table I that maximum pollen germination and tube growth was obtained in 25% sucrose solution under Saharanpur conditions. The viability of the grape pollen can, therefore, be successfully tested in 25% sucrose solution.

Horticultural Research Institute, Saharanpur, S. N. SINGH.

January 19, 1959.

1. Ziegler, A. and Branscheidt, P., *Angew. Bot.*, 1927, **9** (3/4), 340–415.
2. Gollmick, F., *Ibid.*, 1942, **24** (1), 221–32.

REVIEWS

Organic Syntheses with Isotopes. By Arthur Murray III and D. L. Williams. Part II—Organic Compounds labelled with Isotopes of the Halogens, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulphur. (Interscience Publishers, Inc., New York and Interscience Publishers Ltd., London), 1958 Edition. Pp. 1146-2096. Price $ 25.00.

A review of the First Volume of this work appeared recently in *Current Science* (Vol. 28, 1959. Pp. 42-43). The general features of the work were there set out in detail. It is, therefore, not necessary to traverse the same ground again here.

It is not surprising that deuterium compounds occupy a substantial part of the present volume, covering 400 pages. Nitrogen-15 comes next with 150 pages and then Sulphur-35 with 80 pages and iodine with 64 pages. The remaining 170 pages are divided pretty equally between the other isotopes considered, namely, Bromine, Chlorine, Oxygen-18 and Phosphorus-32. Two isotopes of iodine figure in the volume, *viz.*, Iodine-128 and Iodine-131, the latter much more prominently. Two isotopes of Bromine appear, *viz.*, Bromine-80 and Bromine-82 and three isotopes of Chlorine, *viz.*, Chlorine-34, Chlorine-36 and Chlorine-38.

The present volume contains the General Index for both the volumes and is therefore indispensable to a possessor of the first volume. All chemical names are indexed, with the sole exception of common solvents. Page numbers are presented in three modifications: Complete syntheses of compounds are indicated in boldface type, references to preparations without procedural details are given in italics, and the use of compounds as reagents is shown by entries in ordinary type. Index forms of text names are constructed, where feasible, according to the Subject Index usage of *Chemical Abstracts*. Order is primarily based on non-isotopic parts of names. Secondary considerations, in decreasing order of importance, are element symbol, superscript, subscript and locant.

The second volume, like the first, is clearly an indispensable possession for every organic chemistry library.

C. V. R.

The Sources of Invention. By John Jewkes, David Sawers and Richard Stillerman. (MacMillan & Co., Ltd., London), 1958. Pp. xii + 428. Price 31 *sh.* 6 *d.*

Collection of facts and circumstances which led to discoveries helps to trace the growth and development of science during a given period. In this book are presented a great body of data which led to the development of science in the past century.

Part I deals with the background and the successful attempts of scientists to place their inventions at the disposal of technologists. It also points out the difficulties that individual inventor had encountered and how these were overcome by research corporations and the team-work of scientists, towards the development of organised research. The peculiarity of this century appears to lie in the relative decline of invention of the individual type in certain industries with large research laboratories attached to them. A crucial distinction has been made in this book, in purposes, methods and results between pure science and technology. Science is directed towards understanding, and technology is directed towards use. Another point made out is that history of invention shows no sharp break in continuity. In Part II the author has presented case histories of certain important inventions made during the past century. All these cases can be held to belong to the twentieth century, the year 1900, that is to say, has been taken as the dividing line between old and modern inventions. Special mention should however be made of case histories of Cyclotron, Helicopter, Jet engine, Radar, Magnetic recording, Radio and Rockets. A complete and connected account of each of these inventions has been given in a very interesting manner.

This book would be a valuable addition to any scientific library.

S. BALAKRISHNA.

The Theory and Design of Magnetic Amplifiers. By E. H. Frost-Smith. (Chapman & Hall Ltd., London; India: Asia Publishing House, Bombay-1), 1958. Pp. 487. Price 75 *s.* net.

This book provides an excellent treatment of saturable reactors (magnetic amplifiers) for power frequencies and frequencies somewhat higher.

The section on commercial applications could have been considerably expanded, and a much more complete biography than is contained in the rather meagre references would have been helpful. For example, many papers on magnetic amplifiers have been published in the last few years in such journals as *Communications & Electronics* (a publication of the American Institute of Electrical Engineers), few of which are mentioned in this book.

However, the treatment of many phases of magnetic amplifiers is exhaustive. This reviewer found Chapter 13 on *Construction and Design of Magnetic Amplifiers* especially helpful. The portion of that chapter on *Design Procedure* contains much material not generally found in other books on the subject.

A serious omission is the complete absence of any material on the newer uses of magnetic amplifiers, such as their use as audio-frequency amplifiers in public address systems[1] and for radio-frequency amplification and computer applications.[2]

Ferrites[3] receive almost no notice although they have made possible the use of magnetic amplifiers for a whole new field of frequencies.[4] The treatment of a large new array of magnetic alloys should have been expanded, possibly with the incorporation of tables giving the comparative characteristics of these materials.[5]

Nevertheless, this is one of the best books on the subject to appear recently, and any user of magnetic amplifiers in the lower frequency field will find the book very useful.

P. H. C.

1. A paper by J. J. Suozze and E. T. Hopper in *Communications and Electronics*, pp. 297-301, July, 1955.
2. Catalog sheets of Potter Instrument Co., Inc., Great Neck, New York.
3. *New Developments in Ferromagnetic Materials* (a book), by J. L. Snoek. (Elsevier Press, Houston, Texas), as a typical example.
4. *Magnetic Amplifiers: Theory and Applications* (a book), by Sidney Platt (Prentice-Hall, New York), pp. 204-05.
5. *Magnetic Amplifiers* (a book), by H. F. Storm (John Wiley & Sons, New York), pp. 30-31.

Practical Invertebrate Anatomy. Second Edition. By W. S. Bullough. (MacMillan & Co., Ltd.), 1958. Pp. v + 483. Price 30 *s.* net.

In writing this book Prof. Bullough has provided the advanced student of Zoology with a helpful addition to his library. This second revised edition has been prepared as a result of the current theory of the origin and evolution of Metazoa.

Hitherto the Coelenterata were considered to be the most primitive Metazoa but now the researches of Govan Hadzi make it necessary for us to accept that Turbellaria Acoela are indeed more primitive and plausibly evolved from the multinuclear Protozoa. Hence the author examines the Platyhelminthes before the coelentrates and within the coelentrata the Actinozoa are considered as the most primitive class.

The book offers descriptions of 122 commonly studied genera. The happy combinations of details of classification, accounts of the distribution, habitat and mode of life of the genus, and notes on the significance of unusual organs or structures, make the book a *vade mecum* of practical invertebrate anatomy.

References to more detailed descriptions are made available wherever possible and appendices are skillfully introduced to give culture, killing, fixing, and staining methods. A generous supply of semidiagrammatic and well labelled figures aids in the understanding of anatomical descriptions. And, as a finishing touch, Prof. Bullough provides us, in his final appendix, with details of the composition of the fixatives, stains and other solutions which he has mentioned in the course of the text.

Considering that the book will probably be put to constant use by students, the publishers have provided a firm cover. The book is essential for any well equipped Zoology library.

B. R. S.

Perspectives in Marine Biology. By A. A. Buzzati-Traverso. (University of California Press, Berkeley; Cambridge University Press, London N.W. 1), 1958. Pp. xvi + 621. Price 75 *sh.*

This publication includes forty-two papers presented at a symposium held in 1956 at the Scripps Institution of Oceanography to discuss the future bearings in marine biology.

The rapid advances in biology during recent years have been achieved through the application of experimental methods and also the techniques and concepts of other scientific disciplines. But all this work has been almost exclusively on non-marine organisms. At present, only morphology and taxonomy are concerned with the totality of animal forms, while experimental studies of evolution, genetics and biochemical investigations are restricted to a few groups of non-marine organisms. Can such a procedure give us a balanced knowledge of biology as a whole? Will it not be fruitful

if we extend the experimental, biochemical and other approaches to marine organisms also. The papers and discussions in the book under review are all focussed on this problem of experimental approach and on discovering new horizons in marine biology.

In the course of the symposium several illuminating ideas and suggestive possibilities have been brought forward, a few of which may be mentioned. (1) Ernest Baldwin emphasises the need for comparative biochemistry of poikilotherms, especially those dwelling in transitional habitats, and for the establishment of marine biological stations devoted primarily to biochemical studies of living organisms. (2) S. S. Konn links dairy research at Reading to investigations on the source of vitamin A in whales, and wants that research vessels should roam the seven seas and bring back organisms not for enshrining them in formalin but for the investigation of their dynamical biochemistry. (3) Szent—Gyorgyi with characteristic perspicacity suggests that we should develop a quantum-mechanical biology. (4) E. M. Rae suggests that for experimental ecology we should establish a school of plankton husbandry, and that we should try to discover the marine equivalents of the guinea-pig, mouse and fruit-fly for experimental work in marine biology. (5) It is also emphasised that the prime factors in the determination of marine populations are not the gross chemical and physical parameters, but the less obvious factors like vitamins, metabolites, etc., in sea-water. (6) Prof. Hardy points out that we cannot regard marine ecology as exact until we can with reasonable frequency apply to it the crucial test of prediction. (7) Television techniques can be used for selective sampling of deep bottoms, plankton studies and ecological surveys. (8) The behaviour of pelagic organisms may in part be determined by polarised light. In the wealth and variety of marine invertebrates we have very valuable material for genetical, cytogenetical and evolutionary studies.

It will be seen that this book under review is a signpost in marine biology indicating forthcoming developments in marine biology, which will have far-reaching effects on biology as a whole, and confer on it a 'sea change into something rich and strange'. Buzzati-Traverso, the moving spirit behind the symposium, has ably edited this book, which deserves a careful study by all those interested in the biology of tomorrow.

R. V. Seshaiya.

Annals of the New York Academy of Sciences.

Screening Procedures for Experimental Cancer Chemotherapy. By C. Chester Stock and others. (Vol. 76, Art. 3), 1958. Pp. 409-970. Price $ 5.00.

Lymphocytes and Plasmacytes in Nucleoprotein Metabolism. By Margaret A. Kelsall and Edward D. Crabb. (Vol. 72, Art. 9), 1958. Pp. 293-338.

Psoriasis. (Vol. 73, Art. 5), 1958. Pp. 911-1037.

The first monograph, the outcome of the joint efforts of the Cancer Chemotherapy National Center, U.S.A., and the New York Academy of Sciences, constitutes a comprehensive review of the state of knowledge in the field of anti-cancer screening.

Part I of the monograph exhaustively discusses the application of bacterial, fungal and protozoal bioassay methods. The studies on a series of 200 compounds, utilizing 16 microbiological systems have led Foley to conclude that these assay systems are highly useful for routine screening programmes. Exploratory aspects of the use of drug resistant microorganisms, the usefulness of the mutagenicity test as a simple preliminary screening procedure and of lactic acid bacteria for evaluation of purine and pyrimidine antagonists, highlight the special microbiological systems presented.

Tissue culture techniques have naturally attracted attention as useful tools for characterization of nutritional requirements, metabolic activity and morphologic changes of malignant cells. Recent developments in the field, as applicable to screening procedures have been outlined in Part II of the monograph. The tumurogenic activity of tissue cell cultures, comparison of biological qualities of 'transformed' cells of normal and cancerous origin; tumour-specific cyto-toxicity of antitumour agents and highly informative discussion on the variability of results obtained on different cell systems are the main features presented in the second part.

Ascites tumours have been used to a considerable extent in chemotherapy studies of cancer. They constitute a peculiar *'in vivo-in vitro'* test. Part III of the monograph discusses limitations of the technique, parameters of ascites tumour growth, the action of mitotic poisons on hyperdiploid Ehrlich mouse, ascites carcinoma, sensitivity of solid and ascites forms of sarcoma 180 and Ehrlich carcinoma, evaluation against Nelson ascites tumour and screening techniques with ascites hepatoma.

It is not possible to review in this brief account the extremely informative chapters on Lymphomas, Hormone responsive tumours, the human tumour in heterologous hosts, etc. Consultation of the original papers in the volume is sure to benefit all research workers in this field of cancer chemotherapy.

Antibody production, protein synthesis and transport of nucleoproteins to the sites of growth and repair are problems which have attracted the attention of research workers of different disciplines. The second monograph, though small in size, has comprehensively reviewed all available information for and against the tenet that lymphocytes and plasmacytes are primarily true trephocytes that synthesize and store nucleoproteins. The development turnover and fate of the circulating lymphocytes, the origin of plasmacytes, the normal and pathological distribution of these cellular elements in the body, and the significance of the interposition of lymph nodes, spleen and intestinal lymphoid tissue in the circulatory system, as presented, leaves no doubt of their important role in nucleoprotein synthesis, storage and transport. The significance of the presence of lymphocytes and the formation of plasmacytes in wound healing, inflammation, tumour growth and the effect of their depletion on repair, growth, and immunity have been very well discussed. Biochemists, pathologists and clinicians will find in this small volume a highly informative presentation.

In spite of the advances in medical research Psoriasis still remains "the great dermatological mystery". Etiological factors are still indeterminate, while clinical morphology of Psoriasis continues to rest on solid foundation, characterizing the disease as an entity. A detailed study of the pathology and histochemistry has not shed light on any specificity of the disease process.

Though no spectacular therapeutic success has yet been obtained, the steady untiring attempts of histopathologists, chemists, biochemists and clinicians are paving the way for a rational understanding of the disease. This monograph presents the results of these investigations. Comprehensive review on the histochemistry of Psoriasis by Braun Falco, application of electrophoresis to the diagnosis of psoriasis, chemical and biochemical changes in psoriasis and the significance of the enzymatic alterations in the psoriatic scales are some of the interesting chapters in this volume. Observations on the problem of pathogenesis suggesting psoriasis as a pathological acceleration of epidermopoiesis and clinical experiences with an allantoin coal-tar preparation will be found useful by physicians in general and dermatologists in particular.

M. SIRSI.

Books Received

Studies on the Structure and Development of Vertebrates, Vols. I & II. By Edwin S. Goodrich. (Dover Publications, New York), 1959. Chapters 1-8 & 9-14. Pp. 1-485 & 486-837. Price $ 2.50 each Volume.

The Atom and its Energy. By A. D. Gupta. (Asia Publishing House Bombay-1), 1959. Pp. vi + 140. Price Rs. 9·50.

Some Aspects of Multivariate Analysis. By S. N. Roy. (Asia Publishing House, Bombay-1). Pp. vi + 214. Price Rs. 18·00.

Technical Communication 26; *Horticulture in the British Commonwealth, an Outline*. By D. Akenherd. (Commonwealth Agricultural Bureaux), 1958. Pp. vii + 63. Price 10 *sh*.

The Magneto-Ionic Theory and its Applications to the Ionosphere. By J. A. Ratcliffe. (Cambridge University Press, London N.W. 1), 1959. Pp. x + 206. Price 40 *sh*.

Liquid Helium. By K. R. Atkins. (Cambridge University Press, London N.W. 1), 1959. Pp. x +312. Price 60 *sh*.

National Physical Laboratory Symposium No. 8 —Visual Problems of Colour (Vol. I) *and the Needs and Prospects of Subjective Colour Measurement* (Vol. II). By W. D. Wright. (Her Majesty's Stationary Office, London), 1959. Pp. viii + 749. Price £ 2-2-0.

Rape and Mustard. By Dharampal Singh. (The Secretary, Indian Central Oilseeds Committee, Hyderabad-1 Dn.), 1958. Pp. viii + 105. Price Rs. 8·00.

An Introduction to Organic Chemistry. By V. N. Deshpande. (Book Centre, Hubli), 1958. Pp. 232. Price Rs. 4·25.

The Technical Writer. By J. W. Godfrey, G. Parr. (Chapman & Hall, London; India: Asia Publishing House, Bombay-1), 1959. Pp. 340. Price 45 *sh*.

Advances in Pest Control Research, Vol. II. Edited by R. L. Metcalf. (Interscience Publishers, New York-1), 1958. Pp. vii + 426. Price $ 12.50.

Carnegie Institution of Washington—Year-Book 1957-58. (Director of Publications, Carnegie Institution of Washington, Washington, D.C.), Pp. xi + 497. Price $ 1.00.

SCIENCE NOTES AND NEWS

Lady Tata Memorial Trust

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Meherbai Dorabji Tata, 18th June 1959, the awards of scholarships and grants for the year 1959-60.

International awards of varying amounts (totalling £5,065) for research in diseases of the blood with special reference to Leucaemias are made to: Dr. M. Simonsen (Denmark), Dr. M. Bessis (France), Dr. G. Klein (Sweden), Mr. P. A. Pillai (Switzerland), Dr. J. Ponten (Sweden), Dr. (Miss) B. M. Braganca (India), Dr. J. Hastrup (Denmark), Dr. E. Kelemen (Hungary), Dr. A. E. Stuart (Scotland).

Indian Scholarships of Rs. 250/- per month each for one year for scientific investigations having a bearing on the alleviation of human suffering from disease are awarded to: Miss M. H. Gandhi (Bombay), Mr. P. Suryanarayana Murthy (Bangalore), Mr. N. L. Tikotkar (Bombay), Dr. (Miss) M. R. Bakhtiary, (Bombay), Miss M. D. Menon (Cochin), Dr. R. K. Panja (Calcutta), Mr. G. N. Parvate (Bombay).

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board will consider applications for the award of Fellowships, which commences from January 1960, for research work on medical and allied subjects in recognised institutions situated in the Union of India.

The awards normally consist of Rs. 3,000 per year for a Fellowship and Rs. 750 per year towards special equipments or chemicals approved by the Board.

Applications in the prescribed form, which may be obtained from the Secretary-Treasurer, Raptakos Medical Research Board, Dr. Annie Besant Road, Worli, Bombay-18, should be submitted before 30th September 1959.

Award of Research Degree

The University of London has awarded the Degree of Doctor of Science (D.Sc.) in Zoology to Dr. Satya Narayan Singh, Department of Zoology, Osmania University, Hyderabad, A.P.

The Utkal University, Cuttack, has awarded the Ph.D. Degree in Physics to Shri Kulamani Samal for his thesis on "Ultrasonic Propagation and Intensity in Liquid Media".

The Andhra University, Waltair, has awarded the D.Sc. Degree in Applied Physics to Shri V. Venkateswara Rao for his thesis entitled "Study of the Rotational Structure of C_{12} + Bands"; D.Sc., Degree in Chemistry to Srimati G. Somidevamma for her thesis entitled "Analytical Chemistry of Iron III"; D.Sc. Degree in Geophysics to Shri V. V. R. Varadachari for his thesis entitled "Some Meteorological and Oceanographic Studies of the Coastal Waters"; and the D.S.c. Degree in Geophysics to Shri C. Balaramamurty for his thesis entitled "Studies on Physical Oceanography of the Western Bay of Bengal".

Symposium on Scientific Instruments

A symposium on scientific instruments is to be held at the Technical Development Establishment (Instruments), Dehra Dun, under the auspices of the Research and Development Organisation of the Ministry of Defence, on November 4, 5 and 6, 1959.

The deliberations are expected to cover all the aspects of instrument industry in India—its present potentialities and future expansion, design and development, inspection and gauging, testing and certification, rationalisation and standardisation, storage, preservation and tropicalisation, etc.

Papers intended for presentation at the symposium should be addressed to the Convener, Dr. C. S. Rao, Srperintendent of Development, T.D.E. (Instruments), Dehra Dun, so as to reach him on or before July 31, 1959.

Indian Standards Convention 1959

The fifth Indian Standards Convention is scheduled to meet at Hyderabad from 27th December 1959 to 2nd January 1960. The previous four Conventions were held at Calcutta, Bombay, Madras and New Delhi respectively. The Convention will divide into nine technical sessions, covering subjects like the Implementation of Indian Standards; Standardisation and productivity; Design for industrial experimentation; Tropicalisation of electrical and electronic equipment; Latest techniques in chemical analysis; Documentation; Certification for small industries products, etc.

Dr. Irving Langmuir's Complete Works

The complete works of the late Dr. Irving Langmuir are being collected for publication

in a set of six volumes, according to an announcement by Pergamon Press Inc. of London and New York. Dr. Langmuir, who was associated with the General Electric Research Laboratory from 1909 until his death in 1957, was the first American industrial scientist to receive a Nobel Prize. Among the scientific areas in which Dr. Langmuir made outstanding contributions were: high vacuum, solid surfaces, heat conduction, thermionic and gaseous discharges, monolayers, structure of liquids, aerosols and nucleation. A group of 29 leading scientists from throughout the world will serve as members of the Editorial Advisory Board for the Langmuir books. It is hoped that publication of the first of the volumes can be made before the end of 1959.

Five Thousand Revolutions around the Earth

On May 8, at 1-54 a.m., Moscow time, Sputnik III completed its five thousandth revolution around the earth. Sputnik III has now been in flight for 358 days and has covered 228,200,000 km. The first earth satellite in the world, which was launched on October 4, 1957, survived for 94 days, performing 1,440 revolutions around the globe. Sputnik II survived for 163 days performing 2,370 revolutions. When Sputnik III was put in orbit, its maximum distance from the earth (apogee) was 1,880 km., and its period of revolution, 105·95 minutes.

By the time of its five thousandth revolution, the satellite's period diminished to 99·51 minutes, and the apogee of its orbit, to 1,275 km.

To this day both the solar batteries and the chemical sources of power in Sputnik III continue to operate, which makes it possible to monitor it even when it is not illuminated by the sun and is in the earth's shadow. For the results of all the measurements and investigations conducted by means of the satellite to be fixed with respect to place and time, it is necessary to have an exact knowledge of the parameters of its orbit. With this purpose a special automatic measurement centre was set up in the Soviet Union, equipped with the most up-to-date radio instruments. The work of this centre has made it possible to determine the elements of the satellite's orbit with a precision far superior to the precision with which the parameters of the first two satellites' motion were measured.

Since the time of its launching it has been monitored by more than 80 optical stations and observatories throughout the territory of the Soviet Union and over 110 similar stations abroad.

In the period that Sputnik III has been in existence, the co-ordinating-computing centre has issued more than 29,000 ephemerides (statements of computed places) to Soviet monitoring stations, and upwards of 23,000 to foreign centres. In the same period about 92,500 radio messages of the Sputnik's transmitter "Mayak", 10,900 optical observations of the Sputnik by Soviet monitoring stations and observatories and 3,820 observations sent in by foreign stations have been received and treated. Numerous photographic and high precision kine-theodolite observations of the Sputnik have proved highly valuable.—*USSR News.*

A New Ionospheric Phenomenon

Sporadic radio-frequency radiations which are observed sometimes are associated usually with auroral activities. However, as similar effects could be caused by man-made noise or interference, it becomes difficult to establish in an unambiguous way the origin of such unusual radiations. With the object of studying these radiations the Experimental Station at Jodrell Bank initiated a special programme of work, the experimental arrangement of which consists of five separate total-power receivers, all on slightly different frequencies near 80 Mc./s., with the corresponding aerials suitably directed to monitor continuously various sectors of the sky. Two of these aerials are directed at 30° elevation above the northern horizon, one is directed at the zenith, one at 30° above the southern horizon, and the last is rotated continuously so that Cassiopeia *23N5A* is always in the beam. Three of the equipments are in Jodrell Bank and the other two are on individual sites 1 km. away. This experimental arrangement allows easy discrimination against localized interference at any one site, and against distant narrow-band radio-signals.

Normal records from the equipments show the expected diurnal variation due to the galactic background and, in addition, the southern aerial records, radio bursts and noise storms of solar origin. However, during the period January 3-10, 1959, there occurred about ten instances of isolated increases in the noise-level recorded by some of the instruments, together with *simultaneous decreases* in the others. A further very striking isolated event occurred on March 25, 1959, at about 1400 U.T. The records of this event are as follows: (i) The two northerly channels

showed *very strong enhancements*, about 200-400%, in the signal level; (ii) The apparatus continuously following Cassiopeia, which at the time had its aerial toward the north-west, showed a *strong enhancement* of about 50%; (iii) The zenith instrument recorded a marked decrease of at least 50%. The Jodrell Bank magnetometer revealed a change in the horizontal component, about 50 γ, coinciding with these observations.

This event, with its *simultaneous radio-frequency emission and absorption* in different sectors, was more intense than any observed in the January 1959 series. The suggestion has been made that this phenomenon is caused by passage through the ionosphere of streams of charged particles of very high velocity presumably of solar origin. In the upper ionosphere such particles stimulate the generation of radio-frequency energy while at lower levels the result is a net absorption of the background signal. The absorption mechanism is rather well established, especially in polar regions, and may be attributed to the production of abnormally dense ionization in the lower ionosphere. However, very little is known of processes which can generate radio-frequency noise in our atmosphere. It is believed that the impact of charged particles, both of high velocity and high density, is consistent with the environment for production of Čerenkov-type radiation. Other processes are also being considered. It is significant that these isolated events seemed to be the precursors of a period of intense solar activity with associated terrestrial events such as magnetic storms and auroræ.—*Nature*, 183, No. 4669, 1178.

Argus Experiments. Artificial Creation of Electron Belt by High Altitude Atomic Bursts.

The underlying idea for the Argus experiments was due to Nicholas C. Christofilos, Physicist of the Lawrence Radiation Laboratories of the University of California. In October 1957 he called attention to the fascinating physical effects which might be expected to follow an atomic burst in the near-vacuum of outer space, high above the earth and its dense atmosphere. Of the various effects contemplated, the most interesting one promised to be the temporary trapping of high-energy electrons at high altitudes in the magnetic field of the earth. Following the burst there would be thrown off in all directions nuclei of intermediate atomic weight. Most of these nuclei, as is well known, are radioactive and subsequently decay with the release of energetic electrons and γ-rays. Most of the decays occur within a few minutes. The fission fragments themselves are electrically charged and move at high velocity. Hence their paths in the near-vacuum conditions of outer space would be controlled, in the main, by the earth's magnetic field and would be helical ones around magnetic lines of force. The electrons resulting from their decay would likewise move in helical paths in the magnetic field. In accordance with the theory of such motion it could be expected that these high-energy electrons would be trapped in the outer reaches of the earth's magnetic field and would only slowly leak down into the atmosphere and be lost due to collisions with air molecules in the tenuous upper atmosphere. The trapping region would be in the form of a thin magnetic shell encircling the earth and bounded by lines of force. Trapping times ranging from minutes to weeks were estimated for electrons whose helical paths ranged as close to the solid earth as 100 to 2,000 miles, respectively.

As reported already [*Curr. Sci.*, 28 (4), 144] the atomic bursts occurred on August 27 and 30, 1958, in the early morning hours and on September 6, shortly after midnight. In order to produce an electron shell having quantitative significance, it was desirable to minimise the loss of electrons to the atmosphere, and calculations showed that this could best be done by placing the source of the shell between longitudes 0° and 30° W. This follows from the fact that the earth's magnetic axis is tilted and displaced with respect to its rotational axis, so that the edges of the shell would come closest to the surface at these longitudes. The approximate latitude was 45° S. The site of the tests was such as to place the artificially injected radiation shell in a region where the intensity of the natural radiation had a relative minimum.

The directness and clarity of the artificial injection tests have provided a sound basis for interpretation of the natural radiation trapped around the earth. It is likely that many important contributions will continue to arise from the great diversity of geophysical observations being conducted by other countries participating in the International Geophysical Year.—*From White House Reports on the Argus Experiments.*

Heart Faults by Recorder Device

"Inject into the arm and watch the ear" is, in short, the method in this new device for

recording faults in the human heart. An innocuous dye is injected into the patient's arm. It is carried around the blood-stream until it becomes so diluted that the dye concentration reaches a uniform low level. During dilution which lasts about 12 seconds dye concentration is continuously monitored. This is done by passing a beam of filtered light through the lobe of the patient's ear to a photo-electric cell. Variation in dye present in arterial blood causes changes in cell output. This voltage is fed to the recorder.

The high-speed recorder, which operates on the continuous balance potentiometer principle, is designed to register full-scale travel (one millivolt) in one second. A special amplifier provides sufficiently fast response.

The normal curve shows a sharp initial peak followed by rapidly decreasing secondary peaks, thus, recording a steep disappearance curve. In an abnormal condition, *e.g.*, a hole in the septum, blood continuously circulates to the lungs and back without reaching the main circulation. In this case when dye is injected, only part of it is pumped out into the aorta, and the record shows a lower initial peak and the disappearance curve is shallower and longer.—*Electronics*: 32 (8), 74.

Powder Pattern Technique for Domain Structure of Crystals

A new method has been evolved by Bell Telephone Laboratories for delineating the domain structure at the surfaces of ferro-electric crystals. In this method colloidal suspensions of commercial spray-grade sulphur and red lead oxide, each suspended in hexane, are separately used for the delineation technique. Although the colloid as a whole is electrically neutral, individual particles acquire a diffuse, double-layer charge when brought in contact with the liquid, and when a few drops of the suspension are applied to the face of the crystal, under the influence of the "built-in" electric field, the colloidal particles are attracted either to the positive or the negative domains depending on the orientation of their dipole layers.

Thus using sulphur suspensions in hexane, the sulphur deposits on negatively charged domains. If after the hexane has completely evaporated, the second suspension of red lead oxide in hexane is applied, the lead oxide deposits on the positively charged domains. With sulphur and red lead oxide the delineation is brightly coloured and the pattern shows great details.

A dispersion of a cross-linked polymer derived from polystyrene can also be used as the negatively charged colloid, in place of the lead oxide. This can be dyed any desired colour with an oil soluble dye. Hexane is used as the insulating dispersion medium because its low viscosity and low dielectric constant allow the charged particles to move freely toward the ferro-electric domains under maximum electrostatic attraction.

This new powder pattern technique has provided the first information available on the domain structure of a number of ferro-electric materials such as triglycine sulphate and guandinium gallium selenate hexahydrate. It has also confirmed the results of optical and etching methods of delineating domain structure in several crystals.

A New Method of Growing Germanium Crystals

Westinghouse Laboratories report a new technique for growing germanium crystals in the form of thin, uniform flat ribbons. To process conventional germanium ingots into useful form, they must be sliced into thin wafers, ground to the required thickness, further cut into small squares and finally polished. Only then is the germanium ready to be fashioned into finished transistors and other devices. In this processing nearly 80% of the material is thrown away as germanium 'sawdust'.

In the new method it is claimed that the material "grows" directly in the exact form in which this semiconducting substance is used for practical purposes in transistors and similar devices. The new method could radically improve existing methods of making transistors. One can visualise, for example, the process at work in a machine that continuously, automatically, and at high speed turns out finished transistors directly from an input of raw germanium and the two or three other materials required to put a transistor into final form.

The new method may lead to the development of outer-space electronic equipment a thousand times smaller and lighter than anything now in existence.

590-59. Printed at The Bangalore Press, Bangalore City, by C. Vasudeva Rao, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

India: Rs. 12-00. Foreign: Rs. 16-00; £ 1-4-0; $ 4·00.